ONTARIO TEACHERS' MANUALS

NATURE STUDY

AUTHORIZED BY
THE MINISTER OF EDUCATION

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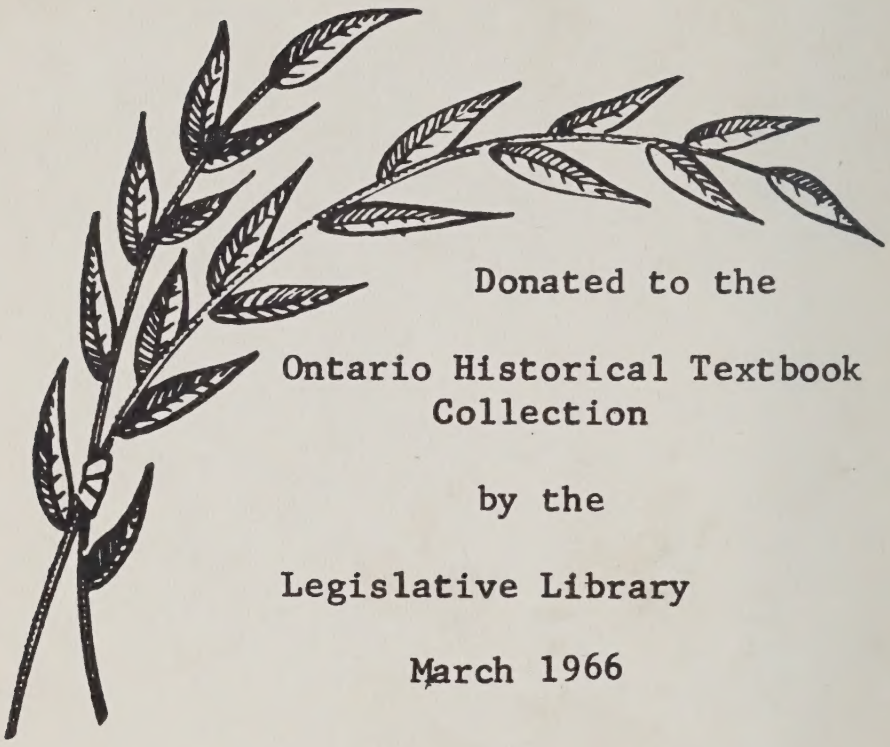

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PREFACE

This Manual is placed in the hands of the teachers of the Public Schools of Ontario to assist them in developing methods of teaching Nature Study and to guide them in selecting and obtaining materials for the lessons on this subject. It is hoped that those who feel a lack of information on the subject of Nature Study, will find help in the matter as well as in the method found in this book; and it is especially desired that all teachers will learn the true spirit of Nature Study which the writers have endeavoured to breathe into the lessons—the spirit which Coleridge expresses in the lines:

> He prayeth best, who loveth best
> All things both great and small;
> For the dear God who loveth us,
> He made and loveth all.

The first Chapter of the Manual deals with the general methodology of Nature Study. Teachers and students are advised to read the first Chapter thoughtfully, because it is through an understanding of the general principles presented there that they will be able to interpret the detailed method of the lessons outlined in the twelve succeeding Chapters.

The Course of Study for the several forms has been slightly amplified by the addition of specific topics and by the insertion of optional lessons. It is realized that it is not always possible for the teacher to obtain a specified insect, or bird, or flower for the lesson. At the same time another type, equally good as Nature Study material, can readily be obtained. The optional types are intended to assure the teacher that the material

that is near home is quite as suitable as that which is specified.

As a further assistance to the teacher in the selection of concrete materials, the topics of the Course of Study have been arranged according to the seasons, each lesson topic being placed in the season for which it is best suited. This division is, however, merely suggestive; and if the teacher finds it more advantageous to teach a certain topic in a different season from that to which it is allotted, he is quite right in making a change.

The Manual stresses the importance of the study of the natural objects in their ordinary habitats. In every school a goodly proportion of the Nature Study Course can and should be taken up in this way. By a proper study of the methods of conducting school excursions and of using directions for the field observations of the pupils, the teacher will understand how Nature Study can be made essentially an out-of-door subject. It must be admitted that every teacher will not find it possible to take up every Nature Study topic in this way, but the teacher who succeeds in basing at least half of the Course upon the pupils' out-of-school observations, need have no qualms about taking up certain of the lessons by other methods, such as basing the lesson upon a story or a picture. The use of stories and pictures has been given a larger place in this Manual than is usual in books dealing with methods in Nature Study.

It is thought that the Course of Study for each Form can be covered within the year. Where it seems impossible to do this, the difficulty may be due to the attempt to carry out too explicitly such sections of the Course of Study as paragraph No. 1, Form III. But it is better that only one or two insects be studied, and that time be left for studying at least one bird and one other animal

(second paragraph) than that either one of these sections should be wholly crowded out.

The many type lessons that are contained in the Manual are intended to suggest principles of method that are to be applied to these and similar topics, but the teacher is warned against attempting to imitate these lessons. This error can be avoided by a careful preparation of the lesson, which should begin with the study of the concrete materials to be used.

For the teacher-in-training a few complete lesson plans have been inserted, and for the teacher who wishes to make use of the project method, an example has been included.

NATURE STUDY IN ELEMENTARY SCHOOLS

AN OUTLINE OF WORK

To assist the teacher in the selection of lesson topics suited to the season of the year, the Course in Nature Study is here apportioned to the seasons. As the holidays come in midsummer, June is to be understood as forming part of the spring season, and August as forming part of the autumn season.

The topics that are allotted to each season are also arranged in the order in which it will usually be found most convenient to take them up. The teacher may sometimes find that, owing to unusual conditions of the season or of the locality, certain topics must be taken in a different order. The opportunity for securing suitable concrete materials is the best guide to the arrangement of the topics.

Some of the topics are stated in greater detail, to make their meaning clearer or to make more evident the options that are permitted in the choice of objects for study.

As there is no Nature Study outlined in the Course of Study for Forms I and II, certain topics in the Geography Course for these Forms, namely, those which can be treated by Nature Study methods, are included within the scope of this Manual. Likewise, some of the topics in Elementary Science that are outlined in the supplementary Nature Study Course are dealt with in this book.

THE TIME-TABLE

It is advisable to have a definite place on the time-table for the Nature Study lessons of each class. In an ungraded school it should be possible to devote three per cent of the teaching time, which is about forty minutes per week, to this subject.

A suitable distribution of this time would be: Form I, five minutes; Form II, ten minutes; Form III, twelve minutes; Form IV, thirteen minutes.

In taking up observational studies, it will usually be found advantageous to have short lessons. Two lessons of six minutes each will sometimes be more effective than one lesson of twelve minutes for even Forms III and IV. On the other hand, there are certain topics which require longer lessons. The teacher of the ungraded school will find it necessary to combine the Forms, so that the lesson periods may be sufficiently long for covering the topics.

TOPICS FOR THE SEASONS

FORM I

AUTUMN

STUDY OF PLANTS:

The recognition of a limited number of flowers, fruits, and trees.

STUDY OF ANIMALS:

The appearance, habits, and uses of a few domestic and pet birds, such as hen, duck, pigeon.

WINTER

STUDY OF ANIMALS:

The appearance, habits, and uses of a few domestic animals, such as horse, dog, cat, rabbit.

SPRING

STUDY OF ANIMALS:

The recognition, appearance, notes, food, movements, nesting of a few wild birds, as robin, sparrow, crow; the mother hen and her family.

STUDY OF PLANTS:

The recognition of a limited number of wild flowers, as hepatica, spring-beauty, trillium, either squirrel corn or Dutchman's breeches, and buttercup.

FORM II

AUTUMN

STUDY OF PLANTS:

The identification of a few common weeds and trees and of a few garden and wild flowers.

STUDY OF ANIMALS:

The identification of a few common insects, the identification of a few common birds, as bronzed grackle, blue-bird, meadow-lark, chickadee, blue heron, bittern.

WINTER

STUDY OF PLANTS:

Comparative study of the potato and the onion.

STUDY OF ANIMALS:

Comparative studies of the chief features of horse and cow, dog and cat, hen and duck.

SPRING

STUDY OF ANIMALS:

Identification of the more common birds; study of the life history of the frog or the toad; daily observations of the robin, from nest-building to the flight of the young; observational study of a butterfly or moth.

STUDY OF PLANTS:

Identification of the more common garden and wild flowers; observational study of the dandelion, including root, leaves, flower, and seeds.

FORM III

AUTUMN

Study of Plants:

Recognition of the more common weeds of the locality; propagation of common house plants from bulbs and cuttings; the comparative study of fruit trees.

Study of Animals:

Observational study of the habits and adaptive structural features of some common birds, as woodpecker, owl, heron; observational study of the life history of a few common insects: types—cabbage butterfly, monarch butterfly, eastern swallow-tail.

WINTER

Study of Animals:

Observational study of the habits and adaptive structural features of some common animals, as rabbit, squirrel, fish; how animals prepare for the winter.

Study of Plants:

Comparative study of some common shade trees and evergreen trees.

PHYSICAL SCIENCE

Minimum Course (None Assigned)

Supplementary Course:

Observation of natural phenomena; simple experiments to show the nature of solids, liquids, and gases.

SPRING

STUDY OF ANIMALS:

Observation and recognition of some of the more common birds as they return in the spring, noting their colour, song, food, and habits; bird protection; observational study of the life history of a few common insects, such as, butterfly, house-fly, mosquito, Colorado beetle.

STUDY OF PLANTS:

Observation and recognition of some of the more common garden and wild flowers.

FORM IV

AUTUMN

STUDY OF PLANTS:

Examination of a few typical flowers so as to recognize the floral organs and the function of each; weed studies continued; methods of seed dispersal.

STUDY OF ANIMALS:

Observational study of the habits and life history of the tomato worm, also of the grasshopper; observational study of the habits, movements, adaptive features, and economic value of such animals as the beaver, muskrat, raccoon.

WINTER

STUDY OF PLANTS:

Methods of eradicating weeds.

STUDY OF ANIMALS:

Means of combating injurious insects; economic value of birds.

STUDIES IN PHYSICAL SCIENCE:

Weather records: temperature, direction of winds, rainfall; expansion of solids, liquids, and gases, with practical applications.

SPRING

STUDY OF PLANTS:

Simple observations and experiments in the germination of seeds; recognition of the common flowering plants of the locality.

STUDY OF ANIMALS:

Observational study of the habits and life history of a common moth, such as Promothea, or Luna, or Emperor (Cecropia); bird identification and the study of typical members of some common families of economic value, such as sparrows, woodpeckers, swallows, wrens; observational study of the habits, movements, adaptive features, and economic values of such animals as the toad or frog, and earthworm.

PHYSICAL SCIENCE

SUPPLEMENTARY COURSE:

Air and liquid pressure; practical applications; oxygen and carbon dioxide, their relation to plant and animal life; capillarity and osmosis; their relation to plant growth; sources of heat; methods of heat transmission; practical applications of heat, steam, and electricity in industries.

NATURE STUDY

CHAPTER I

THE MEANING AND AIMS OF NATURE STUDY

When nature study writers undertake to define this subject, it is at once apparent that they differ as to its meaning. This is not because there is no unity in their conceptions of the subject, but merely because each stresses some particular phase of it. Indeed their attitude is similar to that of the blind men of Hindustan, each of whom described the elephant according to the part of which he had the greatest knowledge

The teacher of the subject will find the following a good working meaning for nature study. Nature study is the study of natural things by most direct observational methods. This means that both the material studied and the method of study are within the field of the child's natural life. Children revel in their associations with Nature's materials; and their imaginations run riot in inquiries as to whence this and that come, and what they are likely to turn into. The teacher's opportunity is to utilize these natural tendencies and to cause the child's investigations to bring more accurate observations and his imagination to reach more truthful conclusions.

It was natural for the ancients to imagine that the flares of the volcano of Lipari were the flames of the forge of Vulcan, at which he moulded swords and spears. It was the task of Science to teach that a force, greater than the ancients had ever imagined, was at work, not merely

shaping swords and spears, but forming the world itself. In like manner it is natural for children to have vague imaginings, such as that weeds are sent to keep children busy during the holidays, or that young frogs come down in the rain. It remains for nature study to teach them the wonderful truths of nature and to guide their imaginations, as they learn through the evidences of their own senses the lesson that weeds are the direct result of the carelessness and neglect that permits seeds to be scattered; and that frogs have gradually, and by a series of wonderful changes, developed from tadpoles; and that they have been induced by the summer shower to change their life in water for one on land. The gaining of information, and the displacement of error and superstition by truth are, therefore, the missions of nature study.

Even more important than the information gained is the mode of gaining it. This is not through the agency of books, but by the natural manner of observation by the pupil. It is not the teacher's part to do the observing, but to see that the pupil observes, and then to help him to make comparisons and deductions from his observations, and thus foster in him the habit of reasoning to correct conclusions.

The child who has examined the leaves of the white oak only, may hastily conclude that all oak leaves have rounded lobes and notches. In his next nature lesson he meets with leaves that are similar to those of the oak, except that the new leaves have sharply-pointed lobes and notches. The teacher directs him to compare as to form, branching, and bark the trees from which these leaves came. One result of the child's observation, comparison, and reasoning is his discovery that this is an oak and that oak leaves have lobes and notches of various forms.

But an even more important result is attained. A certain new bent has been given to his attitude of mind, a bent to explore, to make discoveries, to be self-dependent, to collect, to weigh evidence carefully, and thus avoid the danger of jumping too hastily at conclusions.

We must not, however, make the mistake of thinking that observation and the subsequent mental reactions are intended to displace books and teachers; for we know quite well that the removal of these would deprive us of all the stores of knowledge and all the guides to thought that have been accumulated through all the past. But it can be claimed for nature study that it is a very valuable supplement to these means of education. This claim is based upon a well recognized principle which may be expressed succinctly as follows:

"New knowledge and new interest are based upon old knowledge and old interest."

A certain boy was shown a somewhat complicated but very efficient radio machine. Although he was of a rather mechanical turn, he had had no previous desire to know about radios. He soon showed that he was bored by the efforts to interest him in the machine. There was no old interest and knowledge to serve as a basis for the new. The machine was next shown to a boy who had, unaided, constructed three different types of radio machines. This boy was at once greatly interested in the new machine. The parts, though quite different from the parts of the machines that he had constructed, were quickly recognized, and their action understood by him. This boy's old interest and old knowledge had expanded into new.

In all our efforts at learning, this principle is instantly applied. In the history lesson on responsible government the pupils' old knowledge of the election of the

members of the local municipal council is recalled and used as a basis for interesting them in the new lesson and aiding them to interpret it.

In nature study the child who has been interested in birds and flowers and streams, and who has learned something of their beauty and utility, will be alert to perceive variations in, and to catch new ideas from, all similar objects of nature. The knowledge gained in nature study of plants and streams will serve to give meaning to the more advanced lessons in botany and physical geography. The student of nature who has learned to appreciate the delicate, tremulous forms of the fern and the harebell, will apply the interest and knowledge, during the literature lesson, to give a richer and fuller interpretation to the lines of Scott:

> There is no breeze upon the fern,
>
> E'en the slight harebell raised its head
> Elastic from her airy tread.

One of the most important educative values that can be claimed for nature study is its influence in training the pupil to appreciate natural objects and phenomena, so that he comes to see them with the eye of the poet or artist or nature lover. Wordsworth illustrates this influence clearly in his story of *Michael*, who for more than fourscore years had lived as a shepherd in the rough wooded mountains of the north of England, until—

> These fields, these woods—what could they less—
> Had laid strong hold on his affections.
> They were to him a pleasurable impulse of blind love.

This influence also implies the checking of the selfish and destructive impulses of children by leading them to see the usefulness of each living creature, or the beauty of the harmony between the creature and its environment,

or the fitness of each organ to the mode of life of each particular plant. The boy who learns that toads do not cause warts, but are among our best friends because they destroy innumerable insects that are harmful to garden flowers and vegetables, will cease to persecute and kill these creatures. When the child learns that the dry, brown, wrinkly skin of the toad is Mother Nature's gift to help the creature to escape the keen eyes of its enemies, and that this same skin is fitted for drinking from the moist soil when the toad would otherwise die from thirst, then he will appreciate the beauty of the harmony between this humble animal and its environment. John Ruskin has placed emphasis upon this value of nature study in the following words:

"All other efforts at education are futile unless you have taught the children to love trees, and birds, and flowers."

At all stages in the teaching of nature study, the teacher must keep in mind the fact that it is not the quantity of matter taught, but the interest aroused and the spirit of investigation fostered, together with the development of the habit of carefully weighing evidence, which are the important ends to be sought. With a mind stimulated by a glimpse into Nature's secrets and trained to experiment, the worker finds in his everyday labour, whether this be in an office, in the factory, or on the farm, an interest that lifts his labour above drudgery.

GENERAL METHODS IN NATURE STUDY

THE ESSENTIALS OF A NATURE STUDY LESSON

The first essential of a nature study lesson is that the pupils see the object or phenomenon; that is, that they exercise direct, discriminating observation.

This implies two conditions, namely, a mind prepared and willing to observe, and material to be observed.

It is necessary that the material be so placed that each pupil will have unhampered opportunity to observe. If the objects are small, as in the case of leaves, flowers, pebbles, etc., it is necessary that each pupil should be provided with a specimen. If the objects are large and the points to be observed are conspicuous, a single specimen will suffice for the whole class.

To prepare the pupils for the observation calls for the use of skill and the exercise of enthusiasm for nature on the part of the teacher. The teacher who is thoroughly interested in the subject, and who has prepared himself for teaching by careful observational study of the specimen, will seldom have any difficulty in securing the pupils' interest in the attack. A preliminary discussion, which will arouse a mild controversy as to whether the object has or has not a certain form, has a good effect in stimulating careful observation. Such a preliminary discussion of the movements or habits of the animal that is about to be observed may lead to the query—What is the peculiar point in the form of this animal that fits it for making these movements or for carrying out these habits? This is a direct appeal to the child's natural interest in action and to his curiosity, and will seldom fail to secure active, discriminating observation.

The second essential of a nature study lesson is that the pupil be led to understand the use or meaning of the object or movement or habit which is under observation. It is fundamental that all studies with plants and animals should rest upon the idea that organisms are at work. This means that all structures must, as far as possible, be interpreted with reference to the part they play in

the work of the organism. For example, when a pupil makes a well-directed observation upon a beech tree, he sees that the foliage is arranged in layers, the layers becoming gradually less expansive toward the top of the tree. What is the meaning or use of this? A few well chosen questions will guide the thought of the pupil to the conclusion that the purpose is to give to the foliage of the beech the fullest possible exposure to sunlight and air. A further step will lead him to see what characteristics of the form of the tree trunk and of its branches make the layering of the foliage more noticeable in the beech than it is in other trees. In the case of the elm what features of trunk and branches take the place of the layering of the beech?

The third essential of a nature study lesson is that a desire is developed within the pupil to find out something more. This is the reason why no answer to the last question in the preceding paragraph was given by the teacher. This is left to the pupils to answer by their further observation and thought.

Pupils who have felt the glow of satisfaction at having solved the problem of light relations in the case of the beech tree will attack the new problems with eagerness. They will probably compare oaks, maples, and pines as well.

The teacher is cautioned not to expect too much at first. Let him remember that no two people can see an object in exactly the same way, and that powers of description are widely different. He should encourage every effort of the pupil to make independent observation, and should consider the pupil's description with great care, lest under faulty wording there may be concealed the essence of the truth. Foster the spirit of originality and inquiry, because each new discovery

adds to the world's store of knowledge, and because there are still many more unrecorded than recorded facts of nature.

CONCRETE MATERIAL

It has already been stated that concrete material must be provided and so distributed that each member of the class will have a direct opportunity to exercise his senses, to form judgments, and to deduce inferences from his observations. The objects chosen should be mainly from the common things of the locality. In making the selection the teacher should be guided by the interests of the pupils; that is, he should first find out from them the things upon which they are expending their wonder and inquiry.

A teacher once reprimanded her pupils for being excited about a screech owl that a boy had captured in a barn. She bade the boy set the owl free that they might take up their nature study lesson on the polar bear. Not only did this teacher lose a valuable opportunity to take advantage of an awakened interest, but she also showed a total misconception of the meaning of nature study.

TOPICS AND MATERIAL MUST SUIT THE LOCALITY AND THE SEASON

The material should be selected with due regard to both the locality and the season. It is evident that better nature study lessons can be taught on the elm tree in the school grounds than on the Douglas Fir of British Columbia, and on the robin which has its nest in the tree near by, than on the eagle described in Roberts' animal stories. It is manifestly unwise to teach lessons on ants in winter, or on snow in summer when none can be ob-

tained. Is it not almost equally wrong to teach lessons on snow in late winter, when the pupils have grown weary of snowdrifts? And yet, if they are led to look at the old material in a new way, it may prove quite interesting to them.

USE OF THE COMMONPLACE

It must be kept in mind that, besides leading the pupils to discover new sources of interest, the teacher should strive to accomplish that which is even greater; namely, to lead them to discover new truth and new beauty in the old and familiar. There is always the danger of passing by as uninteresting the objects with which children have associated in early life, while they go in search of something out of the ordinary. It is of great importance that the child learn to love the common natural objects of his environment—the trees, butterflies, and flowers; the rocks, hills, and rippling streams. This end can be reached only through intelligent acquaintanceship. There can be no true appreciation without knowledge. This knowledge the child gets by personal observation, supplemented, when possible, by ideas gleaned from nature lovers.

To illustrate, let us consider the dandelion. Probably no object is more commonplace than the dandelion, yet very few know the most general outline of the plant's life, and few recognize even the leaves. Ask the pupils to discover whether the plant has a stem other than the flower stem. Ask them to find the leaves. The name dandelion is from a French name—*dent de lion*, which means lion's tooth. Why was this name given to the plant? Examine the leaves to find an answer to this question. Ask the class to find how the leaves are arranged. Lead them to perceive how this arrangement

assists the plant to secure and conserve water and to get air and sunshine. A study of the root, flower, and seed will in each case reveal striking points of adaptation of this plant to its conditions of life. Ask the pupils to see in the dandelion what a nature lover has expressed in the following lines:

There's a dandy little fellow
Who dresses all in yellow,
In yellow with an overcoat of green,
With his hair all crisp and curly
In the springtime bright and early
A-tripping o'er the meadow he is seen.

—*Nature Study and Related Literature*, McGovern

STUDY OF ACTIVITY PRECEDES STUDY OF STRUCTURE

Each plant or animal is to be studied as a living active organism. This means, for instance, that the study of a plant is not to begin with a study of the leaves, but with the study of the life functions of the plant, such as its growth, breathing, and taking up and passing out of water. The study of the structure of the leaf is then taken, as a means of helping the pupils to find out how the leaf is fitted for carrying out these functions. Activities are made the starting-point, because these appeal to a child's nature and offer the best means of securing attention. In animal studies, also, the correct order is—What does this animal do? How does it do this? How is it fitted for doing this?

DEFINITE PROBLEMS IN OBSERVATION

In studying the material provided, whether the observations are made in the class room, during a nature excursion, or in the farmyard at home, the teacher should direct the work of the pupils by definite problems. If he wishes to discover what features of an object, such

as an evergreen tree, appeal most strongly to the pupils, he may occasionally be able to do so by giving them the general direction: Make observations upon that tree, in order that you may tell me any facts that you are able to find out about it. But to place material before the pupils or to send them out to make observations without giving definite instructions as to the things to be done or seen, is very likely to prove a failure as a method for directing observation work.

Care must be taken to reach the happy mean of giving specific directions without depriving the pupils of the pleasure of making discoveries. To return to the illustration of the evergreen tree used above, while the problem—Observe the tree and be prepared to tell what facts you find out about it, lacks definiteness, the problems—Observe that the tree is shaped like a cone, and Observe that the trunk runs through the whole length of the tree, tell the pupils too much. They prevent originality in observation and expression. The happy mean would be attained by stating the problems thus—What object does the tree resemble in shape? How far up can the trunk of the tree be traced?

NOTE-BOOKS AND RECORDS

In grades higher than Form I, written exercises should be required, and the pupils should make sketches representing the objects studied. For this purpose a nature study note-book is necessary. A loose-leaf note-book is preferable, because of convenience in making necessary corrections, rearrangements, additions, or removals.

There can be no question as to the value of sketching as a help in observational work. But there is need to beware of the temptation to make the device the end in itself, while the true end should be the effect upon the

pupil. While it is important that the sketching should be done as well as possible, the main purpose of the pupil should not be to make a good sketch, but rather to insure a careful and thorough observation, and there is no better teaching device for securing this result. Usually a person does not see an object with exactness or succeed in fixing it in his memory until he attempts to reproduce it. A pupil whose sketch does not properly represent the object and who recognizes the fact is on the right road to make improvement.

In all records and reports, independence of thought and expression should be encouraged. The drawing and the written description should express what the pupil has actually observed, not what the book or some other member of the class says should be, or has been, observed. When the descriptions are in the pupil's own words, they more truthfully picture his real conception of the topic. The making of notes from the teacher's dictation defeats the fundamental purpose of nature study.

Birds

The chief aims in presenting lessons on birds are:

1. To teach the children to recognize their bird neighbours.

2. To lead the pupils to love them for their beauty, their sweet song, and their sprightly ways.

3. To train the pupils to appreciate the value of most birds as destroyers of insect pests.

Many persons spend their lives surrounded by singing birds, yet they fail to hear their song. Many children see and hear the birds, but, if they have not been brought into sympathetic relation with them, they do not learn to

appreciate them; on the contrary, their attitude gradually becomes one of indifference or of destructiveness. This appreciation may be awakened in the pupils by leading them through effective lessons to find in the birds assistants that contribute to their material welfare and companions that add to their joy in life.

To attain the ends discussed above, the best general method that can be used is the observation of birds in their natural environment and the acquiring of a sympathetic understanding of the life struggles, joys, and tragedies of bird life.

Field excursions are valuable for this purpose, when one or two persons go about in a very quiet way; but good results can seldom be obtained when a large class invades the birds' retreat. Birds are very shy creatures and will fly away or hide when there is any unusual disturbance. For this reason slow, quiet movements are absolutely necessary for success. If the teacher selects a few pupils who are interested in bird study, these can soon be made sufficiently acquainted with the more common birds to be able to point them out to the other pupils.

While the field work is being carried on, a very brief daily discussion of the observations should be held with the class. As soon as the teacher is satisfied that the pupils are making observations upon a bird, descriptions of this bird, as given in a Nature book such as Comstock's *Manual of Nature Study* or *Birds of Ontario in Relation to Agriculture*, by Nash, should be read, so that the pupils may check their observations by those of trained observers. Verses describing the habits or the songs of the birds should also be read, and the pupils should then make an effort to discover whether the authors have interpreted the habits and songs in a satisfactory way. To illustrate—the blue-bird is being studied. John

Burroughs tells us that in his song the blue-bird calls, "Bermuda! Bermuda! Purity! Purity!" Can you hear these words? Does this description of the blue-bird seem to be correct?

> Blithe bonny blue-bird the South wind has sent,
> Each hoping to find a new bird house to rent,
> Or else a snug hole in a post, fence, or tree,
> Where wee baby blue-birds well sheltered may be!
>
> —*Primary Education*, Katharine Beebe

By beginning with the most common and conspicuous birds it is possible for even the youngest and most inexperienced observers to make some progress in their knowledge of bird life. Very often the appreciative study of a single living bird has been the means of converting an indifferent pupil into an ardent student of the birds.

Early spring, when the first birds have returned from their winter sojourn, is the best time to begin bird observations. As there are only a few birds then and very little foliage to conceal them, they can easily be seen and identified.

Among the earliest are the robin, blue-bird, junco, meadow-lark, goldfinch, blue jay, downy woodpecker, and flicker. These are all birds that are easily identified, and it is worth while to be acquainted with them all. But time will permit of the study of only a very few in the nature study classes. This in itself is a good reason why the study should be done in the way that will produce the most lasting influence upon the pupil's life—that is, in the way that will help him to appreciate the living bird.

Under conditions where it is quite impossible to study living birds in their natural haunts, pictures and stuffed birds may be used. These, together with verses and vivid descriptions of the habits of the birds, will prepare the

pupils to recognize them and to become interested in them when they have the opportunity of seeing them.

When pupils describe birds that they have observed, the description should include:

Size—the best method is to compare with some well-known bird; shape; colour of head, back, and breast; conspicuous features, as crest, stripes, bright patches of feathers; movements in flight or when on the ground; song, call notes; state whether in flocks, in pairs, or a single bird.

Patient, persistent, and close observation is required to get the correct description; but when it has been obtained, the bird can be identified by means of a bird guide. Reed's *Bird Guide*, Parts I and II, are two of the most convenient, and *Coloured Bird Pictures*, Mumford, Chicago, and *Birds of Eastern Canada*, Taverner, A.P.—Geological Survey, Canada (50c. or $1.00 cloth), are very suitable for illustrating nature lessons on birds.

The study of birds' nests should be prefaced by a few words upon the sanctity of the bird's home. Any child who is not subnormal can readily be brought to feel a kindly, protective interest in the nest as the home of the bird, and in the baby birds as the children of that home. Teachers of nature study can cite instances of boys who formerly roved the fields and woods in search of birds' nests which they plundered and destroyed, becoming the champions of the rights of birds.

When a pupil finds a bird's nest and reports it to the teacher, the other pupils should be permitted to visit it only upon their promise not to molest the nest or to annoy the mother bird by remaining too long near it. Undoubted good can result from viewing the nest in the proper spirit; and the children must be taught to respect the desire of the bird for quietness and seclusion.

In studying the nest observe: Concealment, protection from storm, size, material, number and colour of the eggs, size and colour of the young birds.

The collecting of birds' eggs should be discouraged, because it almost always leads to nest robbing. The chief cause of this is the practice of exchanging eggs, which induces a boy to take all the eggs from the nest, so that he may have a number to trade with other collectors.

A collection of birds' nests may be made after the nests have been abandoned for the season. This collection will form useful material for a winter lesson upon the ingenuity, neatness, and instinctive foresight of the builders.

Domestic and Pet Animals

When preparing to teach a lesson on domestic and pet animals, the teacher should consider how best to make his lesson fulfil the following important aims:

1. To develop a more complete understanding of the habits and needs of animals.
2. To cultivate a kindly feeling for domestic animals.
3. To secure more humane treatment for them.

To secure these results, observation of the habits, movements, and uses of the animals must be given first place. Animal stories will serve to quicken the imaginations of the pupils and to intensify their interests. A little book published by Thos. Nelson & Son, Toronto—called *At the Farm—the Uses and Abuses of Domestic Animals*, will suggest many points of value for lessons on this topic.

The observation work on certain animals must be

done out of school. In using this method the teacher can direct the efforts of the pupils by assigning to them definite problems to be solved by their study of the animals at home or in near-by fields.

The results of these observations can be discussed in the class in short lessons. It may be necessary to re-assign the problems, in order that the pupils may correct their observations. In these lessons the telling of animal stories relating to the points that are being considered should occupy part of the time.

Certain animals, as the dog, cat, rabbit, hen, and pigeon, can be brought into the school-room and kept in a suitable box. The pupils can then make the observational study directly under the teacher's guidance.

Insects

There are three classes of insects that are of immediate interest to the pupils. The teacher who takes advantage of this natural interest holds the key to success in insect study.

This classification is based upon the capacity of insects to attract our attention, and the classes are:

1. The beautiful insects, including moths, butterflies, and beetles.

2. The wonderful insects, including ants, ant-lions, caddice-flies, etc.

3. The economic insects, including bees, silk-worms, codling-moths, etc.

The last class is especially interesting because of the relations of these insects to the occupations of the home. The successful growing of farm, orchard, and garden crops

practically depends upon keeping a proper balance of insect and bird life.

Some teachers may feel that their knowledge is too limited to allow them to undertake the teaching of this branch of nature study. Any one who has such misgivings should cast them aside. It is not difficult for the teacher who knows nothing about insects at the outset to become acquainted with the few members of each of the three classes named above that attract the attention of the pupils of the nature study classes.

The following suggestions are offered to the pupil or to the teacher who wishes to make a beginning in insect study.

Obtain from the Department of Agriculture, Toronto or Ottawa, Bulletins on the subject of Insect Pests, Vegetable Crops, and Fruit Trees.

Secure a good general book on insects. *Modern Nature Study*, by Silcox and Stevenson, contains illustrations of several of the most common moths and butterflies. These illustrations are sufficiently true to nature to make them helpful in identifying common varieties. Comstock's *Manual for the Study of Insects* is a good general book on insects. This and Holland's *The Moth Book* and *The Butterfly Book* are valuable for those who wish to follow the subject of insect study to any length.

Begin by studying the more conspicuous moths, butterflies, and beetles, and especially the injurious forms that thrust themselves into prominence by causing the destruction of grain, vegetable, or fruit crops in the locality. The utility phase of lessons on insects will appeal to the older children and also to their parents. Moreover, these injurious insects are the easiest ones to identify, and descriptions of their life histories and habits are easy to obtain.

DIRECTIONS FOR THE STUDY OF AN INSECT

Observe carefully the colour, size, and shape of the insect, note the plant on which it is feeding, and the injury it does to the plant. Consult available books on plant pests, and look up the insects that feed upon this particular plant. Then study carefully the description, until the insect is identified. Test whether your observations of the insect agree with those recorded in the book.

An Outdoor Subject

Nature study is essentially an outdoor subject. While it is true that a considerable amount of valuable work may be done in the class room by the aid of aquaria, vivaria, and window boxes, yet the great book of Nature lies outside the school-house walls. The teacher must lead or direct the pupils to that book and help them to read what is written therein.

The teacher's responsibility with respect to his pupils' observations may be dealt with under the following headings:

1. Indoor observations
2. Field excursions with pupils
3. Outdoor observations directed by the teacher
4. Casual observations.

INDOOR OBSERVATIONS

Under present customs and school organization a major part of the nature study work conducted by the teachers of Ontario must be done on material provided for indoor study. Illustrations of how observations may be conducted in class will be found in connection with lesson plans and lessons outlined in succeeding pages.

In some schools a room has been set apart as a nature

study laboratory. In it all the indoor lessons in this subject are taught by a special teacher; and books, specimens, pictures, aquaria, etc., are gathered into this room and conveniently arranged for observation and use.

FIELD EXCURSIONS

As soon as possible after coming to a section a teacher should acquaint himself with the woods, groves, streams, and other haunts that may provide him with materials for his indoor and outdoor work. He can then direct and lead his pupils effectively. Before accompanying a class on a field excursion, he should go over the ground himself, so that he may plan his lesson in accordance with the materials available.

EXCURSIONS CONDUCTED BY THE TEACHER

Long distance excursions may be conducted in the spring to acquaint the pupils with the wild flowers, and others in October to gather seeds, leaves, pupæ, and other materials for winter study. Such excursions may be conducted best on Saturdays, at noon, or after school hours. On these outings children should be trained to examine flowers in their natural environment, and to leave them there, plucking or digging only those required for study. Respect should be shown, also, to birds and their nests, to insects, and to all other living things. After being instructed to conserve our diminishing wild life, the pupils should disperse and, at the sound of a whistle, assemble in half an hour to determine who has found the largest number of varieties of flowers and leaves, etc., in the interval. When summoned the pupils should be seated about the teacher, who will hold before them the specimens, one by one, and, as each is named, offer interesting comments. Such materials as may be

used afterwards will be taken to the school, where, at a later date, points of interest in the outdoor lesson will be reviewed.

Short excursions may be conducted more frequently. All the pupils of the school might be taken together at recess, or the children of the lower grades might be dismissed at half-past three occasionally, in order that the older pupils may be taken on such outings. Sometimes, while the teacher is working out-of-doors with the younger children, the older pupils may be assigned work and be left in charge of a monitor elected by themselves, who shall be responsible for their conduct. Careful preparation should be made for each excursion. One object only should be kept in view and announced to the class before starting. School-room behaviour cannot be expected, but the boisterous conduct of the playground should give place to earnest expectancy. It is advisable that the teacher and the pupils remain together, and that conversation be restricted, as far as possible, to the topic of study.

The following are suggested as objects for excursions: A bird's nest in an adjacent meadow; a ground-hog's hole; a muskrat's home; crayfish or clam in the stream near by; a pine (or other) tree; a toad's day resort; the soil of a field; the pests of a neighbouring orchard; a stone heap or quarry; ants' nests or earthworms' holes; the weeds of the school yard; the vegetable or animal life of a pond; sounds of spring; tracks in the snow; spider's web; birds of the locality.

TYPE EXCURSIONS

A Bird's Nest:

During winter and spring months pupils have been encouraged to observe the birds. Records of spring

arrivals are kept in note-books and on the black-board in the class room. While engaged in observation work the pupils find the nest of a meadow-lark. The teacher is informed, and the pupils are conducted to the spot. Such questions as the following are asked:

What is growing in the field? Of what length is the growth? Of what value is this crop to the bird? How much noise did the mother bird make as she rose from the nest? Why was she so quiet? How is the nest hidden?

The class will halt a few paces from the nest and try to find it.

How many eggs? Their colour? Of what material is the nest composed?

Note the arch of grass so beautifully concealing it.

On returning to school the facts are reviewed. The pupils express their ideas in written composition or drawings, paintings, or modelling of the nest, the eggs, and the surroundings. Frequent visits to the nest should be discouraged; and the pupils should be warned not to disturb the bird, as she may desert the nest on the slightest provocation. When the eggs have hatched, a second visit may be made to see the young birds.

A Wasp's Nest:

When a nest had been discovered, the pupils note how it is suspended and how it is situated with regard to concealment or protection from rain, its colour, the material of the nest, and the position of the entrance.

Is the opening ever deserted? How many wasps enter and how many leave in a minute? Try to follow one and find what he does. Wasps may be found biting wood from an old fence. This they chew into pulp, and from this pulp their paper is made. Get the children to

verify this by observation. If the nest is likely to become a nuisance, smoke out the wasps, take the nest down carefully, and use it for indoor study, examining the inside of the nest to ascertain the nature and the structure of the comb which, in this case, is devoted entirely to larvæ.

OUTDOOR OBSERVATIONS DIRECTED: PROBLEMS ASSIGNED

While most teachers find that want of time and lack of suitable objectives place serious limitations on the class excursion as a regular means of nature study, yet, to be effective, nature study must be made essentially an outdoor subject. It is true that many valuable nature study lessons may be taught to advantage in the class room; but it is not easy for children to understand the adaptation of a structure to an environment which they have not seen, nor to appreciate the functioning of the structure in that environment. Moreover, many lessons on nature study are conducted, of necessity, on a study of objects or phenomena which cannot be brought into the school. Under such circumstances, carefully selected observation exercises may be assigned to the pupils some days in advance of the lesson to which they relate. These assignments should be few in number and clearly and simply stated. Not infrequently it is possible, by daily mention of the observation exercises, to whet the curiosity of the pupils so that they will all find answers to the problems by personal search. In the study of a crayfish in a class room, pupils may not appreciate readily the function of the broad tail and the great paddle, unless they have seen the creature dart backward and stir up mud in which it conceals itself; nor will they understand its protective colouring until

they have searched for crayfishes in the water. Such outdoor exercises as the following, therefore, may render an indoor lesson more intelligible to the children:

Search the waters of the creek for crayfishes and observe as follows:

1. Where do crayfishes stay in the water?
2. Compare the colour and the shape of the animal with the colours and the forms of the objects around it in the water.
3. Touch a crayfish and see how it moves and where it goes.
4. Place several crayfishes in a large dish of water and bring them to school for study.

During a five-minute period at the close of the opening exercises, which many teachers set aside for nature study reports and discussions, the pupils report their observations. By withholding affirmation of the reports, the teacher may succeed in getting all the pupils of his class to make the observations. When further delay promises little further outdoor effort on the part of the pupils, the class lesson is conducted. In this lesson outdoor findings receive full discussion in connection with the relation of function to the structure of the parts of the animal.

CASUAL OUTDOOR OBSERVATIONS OF THE PUPILS

It is important that pupils should be encouraged to observe the many objects and phenomena of their natural environment and report their observations to the teacher. These reports are frequently received and discussed at the close of the opening exercises. Through these discussions the teacher discovers the pupil's especial interests in nature, leads him to correct his false

impressions, helps him to interpret apparently contradictory and unintelligible fragments of experience by relating them to former knowledge, and stimulates him to observe more widely and more closely the objects and phenomena of his environment.

PHYSICAL SCIENCE

VALUE OF LESSONS IN PHYSICAL SCIENCE

1. Lessons in physical science are interesting, both because the matter touches the pupils' everyday lives, and because the experimental method satisfies their natural desire to make things and use them.

2. Physical science teaching helps to form the desirable habits of investigation, of observing relations, and of taking pains in doing work.

3. It exercises the reasoning power, since after each experiment there should come one or more inferences.

4. It develops caution in arriving at and accepting conclusions, and overthrows superstition, prejudice, and reliance on authority and tradition.

5. It has led to the great advance that is being made in all useful inventions to-day. Many of these inventions are in common use in our homes, and pupils should be taught the principles of their construction and operation, so as to be able to use them intelligently.

6. Lessons in science can be correlated with many other subjects of the course of study, and enable the teacher to make concrete some abstract principles that would otherwise be very difficult. Numerous examples will appear in the succeeding pages, showing this correlation with geography, hygiene, and agriculture. Making pieces of apparatus is excellent practice in manual training. Careful drawing of the apparatus and

description of the experiment give practice in art and composition.

SUGGESTED ORDER OF PROCEDURE IN ASSIGNING AND TEACHING LESSONS IN PHYSICAL SCIENCE

1 The lessons should be introduced into the school work naturally, as answers to questions which arise in the regular course of the work or from suggestions made by the pupils or the teacher.

2. A problem may be suggested, and a few days allowed for the pupils to think out a means of solution. If they invent and make their own apparatus, so much the better.

3. The pupils must become acquainted with all the apparatus used. They must know what the teacher is doing and be near enough to see the results.

4. As far as possible the pupils should perform the experiments or assist in the work. If the class is small, the pupils should gather around the table and do the work under the supervision of the teacher. If it be large, one or two pupils at a time should come forward to assist.

5. The bearing of an experiment is not always evident; the teacher must be ready with judicious questions to lead the class to proper conclusions.

6. The results of the experiment should first be applied to the solution of the problem that gave rise to the lesson; after that, as many other practical applications as possible should be sought.

"The science work of the school must be kept in close touch with the doings of everyday life, and especially with the activities that lie nearest to the immediate interests of the boys and girls."

—*Science Teaching*, Twiss

(For Apparatus and Materials, see Chapter XVI.)

CHAPTER II

FORM I

AUTUMN

PLANT STUDY

Identification of Common Fruits

Three lessons are outlined below on the identification of fruits. The teacher may have time to teach but one. The one to choose will depend upon the pupils' previous acquaintance with fruits. Lesson III may be too difficult for some classes.

In teaching these lessons the teacher should have a threefold purpose:

1. To help the pupils to recognize fruits.
2. To develop their powers of observation and expression.
3. To help them to understand the meaning of "fruit," so that they may have an inquiring attitude toward the things of nature.

LESSON I: PLAN

Materials: A collection of common fruits, such as apple, pear, peach, orange, lemon, plum.

Preparation: The pupils are directed to look at the fruits, and the names of the individual fruits are given to, or obtained from, the pupils. They are also trained to use the collective name "fruit."

The pupils are asked to tell all the ways of distinguishing an apple from a plum. After they have given all the differences they can, the teacher tells them that they have not thought of all the ways in which they differ.

A problem is thus created in the minds of the pupils.

The teacher asks: Would you like to learn other ways?

Pupils' Problem: We will now learn other ways of knowing one fruit from another.

Presentation: An apple is passed along the class from pupil to pupil, and each feels the fruit by rubbing it with the fingers, and also smells it.

The pupils are asked to tell what the fruit feels like.

A plum, then a peach, etc., is passed in succession, and each is tested and the qualities compared.

Type questions: How does the feel of the peach differ from that of the orange? Which has the sweeter smell, the apple or the orange?

Application: To test the accuracy of the pupils' use of the senses, a game of Blind Man's Buff is proposed.

A pupil is blindfolded: another pupil hands to the blind man a fruit to be identified. If correct, another fruit is given, and so on until he fails. The pupil who hands him the fruit on which he failed is blindfolded next.

Black-board summary:

Some fruits are smooth.
Some fruits are rough.
Most fruits have a sweet smell.

In the above lesson, while the pupils were conscious only of the problem of learning how to tell one fruit from another, the "teacher's aims" guided him to attend,

not only to the training in fruit recognition, but also to the exercising of the pupils' powers of observation and expression. (See Presentation, Application, and Blackboard Summary.)

LESSON II: OUTLINE

The teacher proposes that the pupils try to see as many fruits as they can before the next nature study lesson. It is suggested that they look in the windows of fruit stores; the teacher promises to bring several kinds. They are to see who can find the most fruits.

CLASS ROOM STUDY

The new fruits that are brought to the class are examined and named as in the first lesson. The sense of taste may be employed in this lesson.

To improve the pupils' powers of expression and reasoning, they should be required to express their opinions in good form.

For example: How do you know that the fruit is a lemon? Its smell and its taste tell me that it is a lemon.

CORRELATION EXERCISE TO FOLLOW LESSONS I AND II

1. Coloured drawings showing apple, pear, peach, orange
2. Paper cutting of lemon, pear, apple
3. Forming the names of the fruits from cardboard letters
4. Writing the names of the fruits in script.

LESSON III: OUTLINE

To teach that such things as squash, melon, tomato, pea-pod, milkweed-pod, redpepper-pod are fruits.

Tell the story, in shortened form, of the house on Jack's Beanstalk, in which lived a surly old giant. Show

an apple and say that this is a little house that grew far up in a tree. Who live in this house? Open the apple and find the seeds. Let us find out if every fruit is a little house in which the seeds live? Open a pear, a grape, finally a plum or a peach pit. What a surly chap the seed must be in the latter case, for he lives all alone and is shut up in walls so tight that no one can peep in, and scarcely any one can break in.

The pupils now know that every fruit is a little house in which one or more seeds live. Require them to express this in their own words.

Note that the pupils have been exercising the inductive process of reasoning; that is, from particular examples they have been drawing general conclusions.

Now open a melon, squash, or pumpkin. Where is the little house in this case? Where are the rooms? What live in these rooms? Then what is a melon? Why do you say a melon is a fruit?

Note that the children are reasoning deductively here; that is, they have begun with general statements and arrived at a particular conclusion.

Proceed with a tomato, milkweed-pod, pea-pod, in a similar way.

Problems: When walking along the road or in the garden, find more of these queer fruits that so few think of as being fruits.

Bring them to school for the nature study collection.

Recognition of Garden Flowers

The following autumn garden flowers are appropriate for recognition by pupils of Form I: Aster, snap-dragon, nasturtium, nicotine, dahlia, gladiolus, marigolds (Scotch,

French, African varieties), sweet-pea, salvia, balsam, cosmos.

Method: Bouquets of flowers should be kept constantly in the school-room. The lessons may be very brief, but while flowers are easily obtainable frequent examinations of those in the bouquets should be made.

All new flowers added to the bouquets should be shown to the children, and their names given to and pronounced by them. The colour, form, and perfume should be described by the pupils. A brief review should be made of flowers previously identified.

Each kind of flower is studied separately, until the pupils have learned to identify that particular kind of flower.

Illustration: To teach the pupils to identify the snap-dragon.

Use a bouquet of snap-dragons containing flowers of different colours.

If the class is large, divide it into groups and divide the bouquet into parts. Arrange each group around part of the bouquet so that each pupil can see the flowers distinctly.

Direct the observations of the pupils to the points of similarity, such as:

1. There are many flowers on each plant.
2. Each flower has a slender green stem.
3. All the flowers are of the same shape.
4. All the flowers look like the open mouth of some creature. From this they get their name "snap-dragon."

Drill: How do you know that this flower is a snap-dragon? Name all the different colours of the snap-dragon flowers of this bouquet. Select your favourite

colour. Out of this mixed bouquet (containing nasturtium, cosmos, snap-dragons) select the snap-dragons. Tell how you know they are snap-dragons.

Application: The pupils should be allowed to arrange the flowers in the bouquets, and then a vote should be taken as to which is the best arrangement. Each child should be encouraged to express a liking for a particular flower.

Such exercises as the above will not only be the means of making the children acquainted with the common garden flowers of this season, but will also tend to develop their appreciation of flowers.

Seat Work:

1. Pupils take turns in arranging the flowers in bouquets.
2. Pupils make a coloured drawing representing flowers, as an aster on its stem, a spray of snap-dragon.

Problems for out of school:

1. Learn to know the names of the flowers that grow in your home gardens or elsewhere.
2. Ask those who grow flowers to tell you the names.
3. How many colours of the aster can you find? How many of the sweet-pea, etc.?
4. Bring flowers to school to put in our bouquets. Tell the name of the flower you bring.
5. Gather the seeds of your favourite flower and keep them for planting next spring.

Recognition of Common Trees

The easiest and most natural way for children to learn to identify trees is by living among them, moving among them, and learning their names from those who know

them. Thus, unconsciously, the children learn to know the distinction between the different families of trees.

The nearest we can come in our school lessons to this natural method of study is to take the pupils on short excursions to visit the shade and orchard trees of the locality.

A way, much less commendable, but under certain conditions the only feasible one, is to base the study of trees upon class room work, and to hope to interest the pupils to such an extent that they will try to make the acquaintance of the trees they see along the roads or around their own homes.

Outlines of lessons of each of the above two kinds are given, with the recommendation that the second be used only when it is impossible to use the first.

Preparation in class: Conversation with the pupils upon the uses of shade trees. A few questions, to cause them to realize that they do not know many kinds.

Announce the purpose of the excursion—To get better acquainted with the trees.

OUT-OF-DOOR STUDY OF TREES

The teacher has taken the class to view the shade trees of a farm or park not far from the school.

Find two trees that are very unlike.

(We shall assume that a maple and an elm are pointed out.)

Find other trees that look like this one.

Now, in what ways are these trees alike?

(They resemble each other in the shape of the tree, the size and length of the trunk, the branches, and the foliage.)

We call these trees maples.

(Maples all belong to one family of trees and are even more alike than boys and girls who belong to one family.)

Look again at the tree that you said was very unlike a maple. Find other trees like this one.

(The name "elm" is obtained or given. Proceed as in the study of the maples.)

Before returning to the school the pupils gather maple leaves and pieces of bark and twigs and also elm bark, leaves, and twigs.

Upon returning to the school-room these are fastened upon the black-board, and the name of the tree is written underneath each group.

Seat Work:

1. Draw the leaves of the elm and the maple. Write the names underneath the drawings.

2. From a heap composed of several kinds of leaves or twigs, sort out into one pile all the maple leaves or twigs, and into another pile all the elm tree leaves or twigs.

During a second excursion take up the study of any two of the following: oak, ash, horse-chestnut, birch.

INDOOR STUDY OF TREES: APPLE AND PLUM TREES

Materials: Pictures of an apple tree and of a plum tree, samples of the old bark of each, and also a bough of each with leaves.

Method of Study: Using the picture of the apple tree, study the parts of a tree as the trunk, main branches, finer branches or boughs, and leaves. When dealing with the two latter, the teacher requires the pupils to examine the boughs and leaves. The children note the crooked-

ness and brittleness of branch and twig and taste the buds or bark.

The plum is studied in the same way; and the attention of the pupils is fixed upon the points of distinction, such as the smoother bark of the plum, the different taste of the twigs, the darker green of the plum leaf.

Problems for out of school:

1. Find apple or plum trees in the orchard at home or elsewhere.

2. How many of each kind are there?

3. How do you know which trees are plum trees?

4. If you find trees that are neither apple nor plum trees, bring some twigs to school, and we will find out what kind they are.

A second lesson of this type would be the study of any two of the following: peach, cherry, pear.

If practicable the teacher may use the study of orchard trees for the excursion, in place of the study of shade trees.

ANIMAL STUDY

The Appearance, Habits, and Uses of a Few Pet Birds, as the Hen, Duck, Pigeon

The most successful nature study lessons on this topic are the lessons in which observations are made upon birds which are kept in the school-room for a few days or longer. A hen, duck, or pigeon may be kept in a box or crate, with clean straw or shavings for litter. The pupils are permitted to feed the bird and to provide it with water.

A very successful teacher of Form I classes has been known to keep a canary in the class room for a whole

term. Instead of disorganizing the discipline of the class, the presence of the bird appeared to have a soothing effect upon the children. They were delighted at being permitted to take turns in cleaning the cage, and supplying the bird with food and water, and also in making arrangements for its bath. In this way, without any mention of kindness and thoughtfulness for animals, the children unconsciously learned lessons on the humane treatment of their little friends.

LESSON I: THE HEN

Questions: Is the hen a rough-looking or a smooth-looking bird?

Point out parts that show your answer to be correct.

Notice the way the hen holds her head and lifts her feet in walking. How does she feel?

Why has she a good right to feel proud?

Find the two wings and the two legs. Under what part of the body are the legs found?

Of what use is the long neck to the hen?

(To answer this watch a hen picking up grain and also trying to guard against any surprise.)

How does the hen use her beak or bill?

Find her nose, eyes, and ears.

Examine the feathers of the hen and find at least two kinds.

Examine her feet. How many toes are on each?

How many of the toes point forward and how many point backward?

What use are the toes?

(To answer this watch a hen getting worms and seeds from the ground.)

What is at the end of each toe?

To the Teacher: The ears do not project from the side of the head. They are covered with tufts of feathers. The use of the toe that points backward will be learned when observations are made upon the perching of the hen. This toe is very useful for taking a firm hold upon the perch. Two kinds of feathers that are observable by even young pupils are the large feathers of the wing and tail, and the smaller feathers that cover the body, to keep it warm and to make the bird look smooth and plump. To find why it is well that the legs are placed near the middle of the body, try to walk with your back horizontal as is the hen's.

LESSON II: THE HEN

If the school is a rural one or is in a village where it is possible for the pupils to make out-of-school observations on the habits of the hen, the following problems may be assigned:

1. Where do hens sleep at night?

2. How do they keep from falling out of bed? Examine the position of the toes when on the perch.

3. Where do hens that run about on farms make their nests?

4. Why do they make their nests in places that are hard to find?

To the Teacher: Remember that long ago hens lived without the protection of a farmyard. Then foxes, wolves, and hawks used to search for their nests and rob them.

5. When hens find some fine, clean, dry soil, what use do they make of it? (This "dusting" is to fill the feathers with fine dust, which helps to kill the insects that annoy the hens.)

LESSON III: THE HEN

For spring observations: Ask some one to tell you how the mother hen hatches little chickens from the eggs. Try to see the chicks picking their way out of

the shells. Watch the mother hen to see how she takes care of the little chicks. Learn how:

1. She helps them to scratch for food.

2. She warms them under her feathers.

3. She covers them under her wings when it rains and also at night.

4. She trains them to be good, by scolding the disobedient and by pecking those that are quite naughty.

5. She chases the dog and the cat, scolds strange people, and pecks meddlesome children.

Now we will think of all the uses hens are to us:

1. They lay eggs.

2. They catch worms and insects that harm our gardens.

3. Their flesh is good to eat.

4. Their feathers make soft cushions.

5. They teach us to be kind to one another.

The following lesson may be substituted for the problems given in Lesson II:

LESSON IV: THE HEN

If a school is so located that it is impossible to carry out the project study outlined above, an alternative is to teach through the use of pictures, stories, and verse. Indeed, the use of these does much to increase the children's interest in the observation work.

Good pictures of domestic birds and animals, called *Infant School Illustrations*, are published by Thomas Nelson & Sons, Toronto. A much reduced copy of one of these is shown.

The study of this picture by the pupils will help them to understand the habits of the mother hen and chicks, and can also be made to stimulate their imaginations.

The following are questions based upon the study of this picture:

1. What do you see in this picture?
2. What is the mother hen doing?
3. Why is she happy?
4. How many little chicks can you find?
5. What is this chick doing? This one? This one?
6. Find the strongest and liveliest chick of all.
7. Why do you think it is the liveliest?

8. Find a mischievous chick. Why do you think it is?
9. Find a chick that is hungry. How do you know?
10. Find the chick that loves its mother the best.
11. Find the father bird. What is he doing?

Help the pupils to interpret the following verses:

Old mother hen had a nest in the hay,
Hidden so snugly away, away,
And in it ten eggs just as white as could be:
I'm glad no one found them, but Rover and me.

Day after day, the mother hen shy
Kept all the eggs quite warm and dry;
Till one by one, pick-a-pack! tweek-a-week!
Ten downy chicks from the white shells peep!

One of the Rambler Nature Books, *On the Farm*, published by Blackie & Son, London, England, contains stories about farm animals, including chickens and ducks. These stories are short and interesting and are suitable for pupils of Form I. As the books are quite small, a set for the school library can be purchased at small cost.

Seat Work:

1. Read a story such as one from *On the Farm*.

2. Plasticine work. Model a chicken-coop and hen and chickens.

3. Draw or cut in paper an illustration of a nest containing eggs and a hen.

CHAPTER III

FORM I

WINTER

ANIMAL STUDY

Appearance, Habits, and Uses of a Few Domestic and Pet Animals: Horse, Sheep, Rabbit, Pigeon

LESSON: THE HORSE

Talk with the pupils about horses and their uses. Use pictures of draught and running horses. There are two in the series *Infant School Illustrations*. Make use of short, interesting stories or anecdotes about horses; one is given below.

Line of Thought:

1. What useful things do horses do for us?

2. Why are horses used for these things instead of oxen or dogs?

3. How can you tell by looking at a horse whether he is kindly treated or not?

Look at the pictures of these two horses. Which one would be better for drawing a heavy load? If you wanted a fast ride, which one would be better for drawing the carriage or for carrying you on his back? Give reasons why you think so, in each case.

How have their owners treated these horses? Give reasons.

Why should we be kind to horses?

Correlations:

1. Model a horse in plasticine.

2. Draw a picture of a horse.

3. Correlate with language by using the following for a reproduction story:

SANDY

There was once a faithful old horse called Sandy, that had lived all his life upon a big farm. A very pretty river ran like a crooked silver ribbon through this farm. When Sandy was a young colt he loved to play in the green pastures beside this river. There he and his sisters and cousins would tease the sleepy cattle, and chase the noisy geese far out into the river, and run races with one another until they were tired. Then they would go to sleep under the shady trees beside the babbling water.

But Sandy's days of colt-hood had long been gone, and he had become an old horse. Then his master, who no longer needed Sandy to do his work, sold him to a farmer who lived many, many miles away. Months passed by, and although his new owner was kind to him, Sandy longed for his old friends back on the farm where he had lived so long, and for the green fields and shady trees beside the rippling river.

One day, finding the farm gate open, he walked out upon the road and looked longingly in the direction of his former home. As he looked he began to walk in that direction. Soon his walk became a trot, and then his trot changed into a gallop. Sandy was returning to his old home.

You or I would probably lose our way if we tried to make such a long journey alone. But a horse knows how to find his way better than we do; and in two days Sandy was in the familiar farmyard once more. He was welcomed so loudly by his friends that his former master came out to see what all the horse noise was about. When he saw that Sandy had come back to his old home and friends, he felt so kindly towards the faithful animal that he bought him back from his owner and gave him the freedom of the green pasture and the shady trees beside the river for the rest of his days.

Problems for out of school:

1. Look for horses of the following colours and learn to know these colours—black, brown, bay, gray, roan, chestnut, dapple-brown or dapple-gray.

2. Learn to know the following kinds of horses:

(1) Draught, agricultural and roadster.

(2) Percheron, Clydesdale, Shire, Hackney, Carriage.

3. By watching horses while they are being fed, find what kinds of food they like best. You may also offer to them such things as clover, corn, apples, carrots, and turnips.

4. How can you tell from a horse's ears that it is (1) cross, (2) frightened, (3) listening?

5. By looking at the hoofs of work horses that have not been shod, find out how useful the shoes are to them. Watch a blacksmith shoeing horses, and be prepared to tell us everything that was done, and also whether it hurts the horses.

LESSON I: SHEEP

This lesson is suitable for a class in a city school. It is often impossible for the pupils to make observations on the sheep. But perhaps some of them have visited a farm and these, of course, are delighted to have an opportunity to tell what they know about sheep.

Begin the lesson with a conversation about sheep. Those who have been on a farm and have seen sheep should be given a chance to describe the woolly coat, the colour, the height, the size compared to that of a large dog or small pony, the timid movements, the habit of living close together in a flock.

As some pupils, perhaps the greater portion of the class, have never seen a sheep, the teacher should show a picture of sheep and lambs; while those pupils who have seen them point out the characteristics which have been named above and others that may be represented in the picture. The surroundings shown in the picture are also discussed. (See picture in the series *Infant School*

Illustrations.) The food of the sheep, its winter quarters, and the playful habits of the young lambs are described.

The teacher should have a sample of wool for the pupils to examine. The process of making yarn for weaving into cloth can be illustrated by twisting the wool. The pupils may learn about the thickness and warmth of the winter fleece and the necessity of removing it by shearing in the spring, so that the sheep may not suffer from such a heavy coat during the warm weather. They should also understand why sheep do not need a very warm barn to live in in the coldest weather, a shelter from the wind and rain and snow being sufficient.

LESSON II: THE SHEEP

This lesson is one comprising home problems, and is suitable for a class in a rural school.

The teacher should arouse the pupils' interest in the habits of sheep. This may be done by a short story such as the following:

THE STORY OF BĂWH

A long time ago there were no sheep in the world but wild ones. These lived among high hills where there were many rocks. There was one flock of very nimble-footed sheep that had a wise old leader. All the people of the hills knew this leader as Băwh. They gave him this queer name because his voice was so loud and so gruff. In the early morning, before it was really light, Băwh used to lead his flock down into the valleys to feed upon the soft, green grass that grew there.

A fierce old bear tried many times to surprise the sheep while they were eating their breakfast. But Băwh's keen eyes and keener nose always told him of Bruin's approach. His loud, gruff voice would at once sound an alarm, and off he would bound up the steep hill-side. All the mother sheep, with their baby lambs at their sides, would follow closely after him. Băwh knew every rough path that led to the high, rocky crags up which the sheep and lambs could leap and scramble faster than old Bruin could follow. Among these crags they were safe.

Problems:

1. Watch the flocks of sheep to see whether they follow their leader when they are frightened. Ask those who know the ways of sheep to tell anecdotes about sheep doing this.

2. Watch the young lambs at play. What games do they play? Describe some of the thimgs they do. Did you ever see one jump on top of a stone and dare the others to put the king off his castle?

3. Examine the feet and legs of a sheep. In what way are the hoofs fitted for climbing steep hills? Notice that the upper parts of the legs have large, strong muscles giving power for leaping. This makes a leg of lamb of good size for us to eat.

4. How do young lambs practise fighting while at play?

5. Offer to the sheep different kinds of vegetables and other foods, and in this way find out what they like to eat.

6. How fast can lambs a few weeks old run? Recall the story of *Bǎwh* and tell why nature gives sheep strength to run so fast. What kind of legs have lambs that they are able to run and leap so well?

The pupils are given time to find answers to the problems. A class discussion is then taken. The pupils are encouraged to tell what they have observed and what they have learned through the help of those who understand the habits of sheep.

To the Teacher: It is well known that sheep follow their leader blindly. This is in response to an instinct that was so useful to their wild ancestors, as is illustrated in the story of *Bǎwh.* Farmers make use of this instinct by putting a bell on the neck of an old sheep—the bell-wether. If the flock is alarmed by a prowling dog, they all rush to where they hear the sound of the bell, and the loud ringing of the bell usually weakens the nerve of the marauder, and also awakens the owner of the flock.

The games played by the young lambs are well fitted to prepare

them for the kind of life that sheep lived when in a wild state. When only a few weeks old the lambs can run as fast and as long as their mothers can. They are "almost all legs" at that stage of their growth.

Correlation: Picture Study of Sheep in *Infant School Illustrations* (Thos. Nelson & Son, Toronto)

LESSON I: THE RABBIT

The lesson is introduced by a conversation with the pupils about their various pets.

Since we are to have a rabbit brought to the school we must know how to take care of it.

Where do wild rabbits live?

What sort of home does a rabbit have?

In what ways does this home protect the animal?

Hence, what kind of home must we have ready for the rabbit?

What does the rabbit eat?

(Get answers from any who have pet rabbits.)

Are there any of these foods that are not good for the rabbit's health?

Give a list of foods that you can bring for the rabbit.

Why will a rabbit, when kept in a hutch, require less food than one that runs about?

Since the rabbit likes a soft bed, what can you bring for that purpose?

The interest of the pupils will be increased by reading a suitable story. *The Tale of Peter Rabbit*, by Beatrix Potter, is recommended.

LESSON II: THE RABBIT

Observations: The teacher or a pupil brings a rabbit to the school-room, where, during recreation periods, the pupils make observations on topics suggested by the

teacher, such as, its choice of food; its timidity; its movements—hopping, squatting, listening, scratching, and gnawing.

The pupils' observations are discussed in the class and are corrected or verified.

Discuss why we like the rabbit as a pet, noting its gentleness, beauty, liveliness, playfulness, soft fur, and clean habits.

To the Teacher: Wild rabbits live in the woods or in shrubbery at the edges of the fields. The home of the rabbit is either a burrow under the ground, or a sheltered place under a root or log closely concealed among the bushes. This home is dry and affords a protection from enemies, and from wind, rain, and snow. From this we know that we must provide a dry bed in a strong box in which it will feel safe, and in which it will be protected from wind and rain.

The food of the rabbit consists of vegetables and soft young clover and grains. It also gnaws the bark of trees, and in winter it feeds upon bark and buds. We can, therefore, feed our rabbit carrots, beets, apples, oats, bran, grass, and leaves of plants; and we must provide it with some twigs to gnaw, for gnawing helps to keep its large chisel-shaped teeth in good condition. We must be careful to give it exercise and place a dish of water in the hutch for it to drink. But we must not give it any cabbage, because cabbage is not good for the rabbit's health.

Impress upon the pupils the cruelty of rough handling, and of neglecting to provide the rabbit with a clean, dry home.

The following pet animals may be studied, using the same order and general method of treatment: pigeon, cat, canary, guinea-pig, white mouse, squirrel, parrot.

In many cases these animals can be brought to school by the pupils, for the best lessons grow out of the actual care of the pets. The study of a pet bird may be conducted along lines similar to the outline given below for the study of the pigeon.

Correlations: Literature and reading: Ernest Thompson-Seton's *Raggylug.*

Art: Charcoal drawing representing the rabbit in various attitudes—squatting, listening, hopping; modelling in clay or plasticine; paper cutting.

Language: The vocabulary of the pupils is enlarged by the introduction of new words whose meanings are

made clear by means of the concrete illustration furnished by direct observation of the rabbit.

These new words are used by the pupils in sentences which they form in describing the rabbit; as, hutch, gnaw, padded, cleft lip, timid.

Examples: The rabbit has padded feet so that it can walk without noise. The rabbit has a soft bed in its hutch.

LESSON I: THE PIGEON

A pigeon is kept in a cage in the school-room, and the pupils observe its size as compared with that of other birds; outline of body, including shape of head; the feathers, noting colours, quill feathers, and covering or contour feathers; manner of feeding and drinking; movements, as walking, watching, pecking; the cooing sound.

The owner of the pigeon or the teacher describes the dove-cot, the necessity of keeping it clean, the use of tobacco stems for killing vermin in the nest, the two white eggs, the habits of male and female in taking turns in hatching, the parents' habit of half digesting the food in their own crops and then pouring it into the crops of the young, the rapid growth of the young, a second pair being hatched before the first is full-fledged.

Descriptions of the habits of one or more well-known varieties—pouters, fantails, messengers, tumblers, etc. Read stories of the training and flights of homing pigeons, from Ernest Thompson-Seton's *Arnex*.

LESSON II: THE PIGEON

This lesson is suitable for a class that has not had an opportunity to make observations on a bird in the class-room. The teacher assumes that there are flocks of pigeons in the neighbourhood.

THE PIGEONS OF VENICE

Far away across the sea there is a very beautiful city called Venice. Many years ago this city was at war with a strong enemy. The soldiers of this enemy were all around the city, and the people inside could get no food. They were almost starved to death. One evening they gathered in the market-place to talk about what they would do. They said, "If help does not come to us in the morning, we shall have to give our city to the enemy."

Morning came but it brought no help. Just as the people were about to yield to the enemy, a little white pigeon alighted within the city gate. It seemed to be very tired and much frightened. A kind old man took it gently in his hand and stroked its broken feathers. "What is this?" he cried. As he spoke he pulled out a feather to which was fastened a tiny roll of paper. On the paper was a message which said that help would come before the end of the day.

The good news gave the people strength to hold their city for that day. Then help came and they were saved.

Ever since that time the people of Venice protect the pigeons, and this city has more of these beautiful birds than any other in the whole world.

Problems based upon this story:

1. How fast do pigeons fly? How do their wings move when flying swiftly?
2. Find out the colours of pigeons.
3. Ask those who know the ways of pigeons whether every pigeon would carry a message as the one in the story did.
4. How do they walk and what do they busy themselves at upon the ground?

After allowing sufficient time to the pupils for making observations, the results of their investigations should be taken up in the class.

The story should be reviewed and may serve as a basis of a language lesson.

Seat Work:

1. Model in plasticine a pigeon alighting on a post.
2. Make a paper cutting showing a flock of pigeons.

CHAPTER IV

FORM I

SPRING

ANIMAL STUDY

THE recognition, appearance, notes, food, movements, and nesting of a few common birds should be taken up with the class.

LESSON: THE ROBIN

Time: April.

Teacher's Aim: To arouse the pupil's interest in the robin, so that he will be anxious to see the bird and to learn its ways.

When the pupil has learned to recognize the living, moving bird by means of its appearance, actions, call notes, and song, he has had a true nature study lesson on that bird. Pictures, word descriptions, and stories of bird life are aids to the lesson; but the strongest nature influence comes from the sympathetic bond between the child, as a lover of life and action, and the living, active bird.

Conversation:

There is a bird that sings so loudly that he wakens me every morning. This morning I saw him in the top of a tree. In his song he seems to say, "Cheer up! Cheer up! Get up early! Get up early!"

Do any of you hear this bird singing before you get up?

What bird is it?

What makes the robin so happy in the spring?

He has been away all winter, far away in the south, and has just come home.

What then makes him happy?

People who live in the south tell us that the robin never sings for them.

When you see the robin I am sure you will say he looks as happy as his song says he is.

Who wants to see the robin and hear him sing?

I will tell you a secret. The robin is happy because he and his wife are building a pretty new home.

(Show a picture of a nest with eggs.)

Let us try to see the robins building their nest and watch them as they sing.

You must first make sure that you know the robin when you see him.

To the Teacher: The children may be taught to recognize the robin in any one of the following ways. The way to be chosen by any teacher will be suggested by the conditions in each case.

1. Teach, by having the pupils watch the robins in the school grounds during recess or from the class room windows during school sessions. The pupils' attention can be directed to the distinctive colours, to the movements of the birds, and the meaning of these movements.

2. Show the pupils a good picture of a robin, and discuss its size and distinctive colours. The pupils are then directed to look for robins, either early in the morning when the birds are singing in the trees, or in the evening when they are hopping about upon the ground. Observations to be made as in Number 1.

3. Put each pupil of the class under the guidance of an older pupil of the school. The latter will assist the younger pupil to recognize the robin and to make observations as in Number 1.

4. Teach, by having a class excursion to a neighbouring park, shrubbery, or orchard.

EXERCISE

When the pupils have learned to recognize the bird, they should be directed to watch for it and to report all the places in which they have seen it. They should

also be expected to observe what the robins were doing, whether singing, chirping, listening, or catching worms.

Ask them to find out if the robin's song sounds like "Cheer up! Cheer up! Get up early! Get up early!"

Require them to observe the distinctive colours, such as the red breast, gray-black head and back, and the white feathers at the margins of the tail.

The following story told by the teacher will help the pupils to find the white feathers of the tail, and will also help them to understand the use of these white spots:

A mother robin was trying to guide her family through a dark wood to a place where juicy red berries were to be had. "Perk! Perk!" called the young ones. This meant "Mother, we cannot see you in the dark wood."

"Chirrup!" called the mother, as she shook her tail in their very faces. In this way she was saying to them, "Wake up, and watch the little white flags I am waving! Watch these and you can follow me!"

Try to find the two tiny white flags on mother robin's tail.

LESSON I: THE CROW

A class-room lesson to interest the pupils, and thus prepare them for making observations on the appearance and habits of the crow follows.

Teacher and pupils hold a conversation on crows, in which questions such as the following are asked:

Where did you last see any crows? How do you know a crow from other birds?

The answer to this question will include such points as size, colour, flocks, sounds, where seen or heard. A good picture of a crow may be used, after the pupils' store of ideas is exhausted, to show shape, colour, feet, eye, etc. Why do crows call "Caw" so often? Compare this to playmates calling to one another; also to mothers calling to their children to be careful.

The teacher may now tell a story which will serve as a basis for out-of-school observation. The following is suggested:

THE FARMER AND THE CROWS—A TRUE STORY

A farmer had a fine field of young potatoes. He had worked hard in planting the little pieces of potato, called "sets." From these sets the young potato plants had grown, and the farmer was very proud of his crop.

Large flocks of crows came from the woods near by and alighted in the field. The crows began to pull up the young potato plants and to eat the sets that the farmer had planted.

"I must put a stop to that," said the farmer, "or my fine crop of potatoes will be ruined."

He took up his gun and went out to the potato field. The crows were quite bold and did not fly away. Soon two dead crows were hanging from a stake in the field.

In spite of this warning the crows soon came back to get more potatoes. This made the farmer very angry. He again took up his gun and stepped out of the house. At once from the top of a tall tree, a loud, sharp "Caw! caw! caw!" was sounded. This told the crows in the field as plainly as you could say it in words, "Fly for your lives, he is coming!" The crows were gone from the field like a flash, and with many angry "caws" were soon out of sight in the woods.

For many days the farmer tried, in every way he could think of, to steal upon the thieves. But the sentinels on tree and hill made such good use of their sharp eyes and ready tongues that not another crow could the farmer shoot.

Correlations and Seat Work:

1. Use the story as a basis for language—
   (1) For teaching new words, as ruined, warning, like a flash, out of sight, steal upon, sharp eyes, sentinels.
   (2) For a reproduction story.
2. Dramatize the story, the children taking the parts.
3. Use the lesson on the crow as a preparation for an art lesson, drawing the crows in a potato field. Use as a basis for a paper-cutting exercise.
4. Base arithmetic problems upon this lesson.

Example: There were nine crows in a flock. Each crow pulled up two young potato plants. How many plants in all were pulled up?

LESSON II: THE CROW

Lesson II should be based upon out-of-school problems. These are suggested by the thought of Lesson I.

Problems:

1. Try to get close enough to a crow to see its beak and the beautiful colours of the neck. Why is this beak a good one for getting the potato sets?
2. Watch the wings of a crow when he is flying. How does he use them?
3. Look in potato fields, corn fields, or oat fields, to find whether the crows are pulling the plants up.
4. Ask the farmers what they have known crows to destroy, and whether they destroy insects that do harm to the crops.
5. Where were the sentinels of the flock and when did they call?

Pupils of rural and village schools should be able to make a number of observations in response to these problems, and one or more lesson periods may be spent in discussing them.

LESSON III: THE CROW

A crow's nest is easily obtainable. The teacher and the pupils of the upper classes of the school, by searching in evergreen and other trees, will find at least one nest. When it has been abandoned, it should be secured and kept in the school collection. If a crow's egg can also be secured, it will add to the interest in the study of the nest and the nesting habits of this bird.

If it is possible for the class to make observations on the nest building and the rearing of the young, the latter method is the preferable one.

PLANT STUDY

LESSON I: THE HEPATICA

The teacher should begin the study of the spring flowers by bringing into the school-room a bunch of hepaticas. This is one of the earliest of the spring flowers. This fact, together with their delicate beauty, makes them welcome guests.

Along with the flowers there should be a number of leaves. With the earlier flowers, last year's leaves only will be found. These are either greenish-brown or dull brown. With the later flowers will be found the young leaves. These are thickly covered with downy hairs.

The teacher groups the class around the table for the observation lesson on the flowers and leaves.

The pupils are asked to find out the colours of the flowers and are then asked to count how many colours there are.

The variation in colour is characteristic of the hepatica, as it is of the violet. How would you know that these, in spite of the different colours, are all the same kind?

As children are not so ready to perceive resemblances as they are to perceive differences, some directions must be given to aid their observations. Hence the following questions:

What holds up all the flowers? What differences can you find in the stems?

How much alike do the little parts in the very centre of each seem?

Smell the flowers. What is the perfume like?
How many green leaf-like parts are below each flower?
What is the shape of all these green parts?

Here the teacher may give the name. All these flowers are hepaticas. Give suitable drill on the pronunciation.

The leaf should now be examined. Its peculiar rounded lobes; its long, slender stem, and its thick, leathery structure are features by which it can be recognized. If there are any young leaves, the furry covering should be observed.

LESSON II: THE HEPATICA

The pupils should apply what was learned in the class lesson in making the acquaintance of the hepatica in its natural surroundings. The teacher may make this the occasion for an excursion, or may put the younger pupils under the guidance of the older ones, and the latter will help them to find the flowers. In brief, it must be realized that the study of the hepatica is not complete until the pupils have seen the plant and flower growing in its native woods.

Problems:

1. Find the hepatica growing in the woods, and see what keeps the flower up from the ground. Try to remember whether these plants grow in dark, shady places in the woods, or in open, sunny places.

2. Look for old leaves or for young leaves such as you saw in the lesson at the table.

3. If you find flowers that look like hepatica flowers but have not the hepatica leaves, bring some of them, as well as some hepaticas, to school for the rest of us to see.

When discussing the pupils' efforts to answer the problems, the teacher should have a complete specimen of the plant, so that the children may see the relation of leaf, flower, and root.

At this stage the teacher may reveal to the pupils the secret of the hepatica. Are the little green leaves that are close to the coloured leaves part of the family? By turning back the two green leaves, they will find that they are separated from the delicately coloured leaves by a little piece of stem. This is the hepatica's secret—a little family quarrel has separated the two green sisters from the group of prettier sisters. By this you can always know an hepatica.

NOTE—To the child the spring-beauty looks very much like an hepatica. Probably some will bring spring-beauty flowers in response to the problems given.

Correlations:

1. Art. Draw an hepatica plant, and show the colour of the leaves.

2. Oral composition. Tell a story about your "hike" to the woods where the hepaticas grow.

3. Study as a memory gem:

> Come up, April, through the valley,
> In your robes of beauty drest,
> Come and wake your flower children
> From their wintry beds of rest;
> Come and overblow them softly
> With the sweet breath of the south.
>
> PHOEBE CARY

See *Nature Study and Related Literature*, McGovern

LESSON: THE SQUIRREL CORN

Teacher's Story: You have all heard the Bible story which tells us that a long time ago there were seven years of famine over all the earth. Egypt was the only land that had stored up corn to feed her people. When the men and women and little children of other lands were starving, Egypt had plenty of food.

We are now going to see a plant that has been taught by Mother Nature to store up corn. This corn is useful for feeding the plant when it can get no other food. (The teacher has secured an entire plant and has it planted in a flower-pot.)

The attractive queer-shaped flowers are examined and admired. The pupils smell the flowers and note the sweet perfume. The colours in the flowers—green, white, and purple—are observed. The beautiful, delicate, fern-like leaves are examined, and an effort is made to help the pupils to appreciate their graceful forms.

Has any one guessed where this plant has its store of corn?

Some may guess correctly, but perhaps a question may be needed such as—Where does mother store her supply of pumpkins, potatoes, and fruits for your winter food?

Let us see whether this plant has a store under the ground.

The pupils then begin to dig in the soil and soon unearth the golden grain that looks so much like corn.

They cut or bite the grains to see if they are really corn. We call this squirrel corn, and the whole plant is called the squirrel corn.

Why was this plant able to grow and to have such beautiful flowers and leaves while it is yet too cold for any but a few flowers to bloom? The answer is "Because it stored corn for the hard times"—that is, for the cold weather and for a dry summer season.

This lesson, as in the case of the first lessons on the hepatica and spring-beauty, should be followed by out-of-school observations of the plant. The same method of carrying out this observation work is advised, and problems similar to those on the hepatica are suitable.

In the case of Problem Number 3, the pupils will probably find the plant called Dutchman's Breeches.

The latter closely resembles the squirrel-corn, but may be distinguished from it by the following differences:

1. The flowers of the Dutchman's Breeches are white.
2. They are not fragrant.
3. The store of food is not in grains like corn, but in rougher and more irregular bodies.

These differences are probably too minute to make suitable studies for a Form I class. The teacher should, if possible, avoid having a lesson upon them; but if the pupils show any interest in learning the difference, it is right to gratify this desire.

Correlations:

Arithmetic. Count the number of grains in the store of a single plant.

Art. Draw a flower cluster.

Language. Tell the story of the famine and the storing of the corn.

In addition to the plants already dealt with, the Spring Course for Form I could include the study of the trillium and the common buttercup. The teaching of lessons on these should give no difficulty to the teacher who has taught lessons on the earlier flowers of the season. The two essentials for the successful teaching of this branch of nature study are:

1. The teacher must have a thorough acquaintance with the plant, obtained by reading, but especially by a study of the plant in its natural surroundings.

2. The teacher must have as his aim, not merely to teach the pupils the names of the plants and their organs but to awaken their interest in them as living objects, and to help them to appreciate the work of flowers in beautifying the earth.

If it is found more convenient to study plants other than those named, the teacher is at liberty to make the substitutions.

Possible substitutions: Bloodroot, which blooms early, for the spring-beauty; wild ginger, which also blooms early, for the hepatica; dog-tooth violet, for the squirrel corn; Jack-in-the-pulpit, for the trillium; Solomon's seal, for the buttercup.

CHAPTER V

FORM II

AUTUMN

PLANT STUDY

Identification of Common Trees

In these lessons the teacher's aim should be to assist the pupils in identifying the common trees of the locality, and to teach them to become appreciative of the beauty and the value of trees.

In order that the pupils may be able to identify a tree, it is necessary that they observe its distinguishing features, and repeat this observation until the recognition becomes a habit.

In nearly all cases the leaf affords a ready means of identification. The fruit, also, when it is on the tree, is usually distinctive. For example, the key is a definite indicator of the maple, and the acorn of the oak. In certain cases, such as the elm, the general shape of the tree is noticeably different from that of other trees. Though the differences in the barks of trees are not always easy to perceive, yet, in the cases of the birch and of the beech, the bark is of assistance in identifying the tree.

The lessons should help the pupils to recognize as many of the distinctive features of the common trees of the locality as is possible within the limits of the time that can be given to this topic.

Since it is chiefly the branching and the foliage of the tree that give it its beauty and usefulness for shade and

ornament, the attention of the pupils should be directed to these, also, as much as possible.

Pupils who live in a community where there are many trees will probably be so familiar with them that the study of more than one can be undertaken in a single lesson. The teacher must use his judgment in finding out how many studies should be taken in a lesson.

LESSON I: ASH AND BEECH

It is assumed that these trees are represented in the woods or the shade trees in the locality of the school.

From each tree the teacher has obtained as many leaves as there are pupils in the class. The beech leaves are distributed to the pupils, and they are asked to name the kind of tree of which these are the leaves. If no pupil knows, the teacher gives the name and writes it on the black-board. A few features of the leaf are then observed. For example:

1. How thick is the leaf? Compare it with cloth or silk.
2. What are the little lines?
3. What is at the end of each, out at the margin of the leaf?

The ash leaf is then examined in a similar way. The following features should be noted:

1. The leaf is made up of a number of parts. These are the leaflets, and the leaf is compound.
2. The upper surface is a very dark green. The lower is lighter green.

The pupils are then told the locality in which these trees may be found and are given the following problems:

1. Find the ash trees and the beech trees.
2. Find the fruits of these and bring samples.

3. Examine the bark of each.
   (1) How smooth is the bark of each?
   (2) What is the colour of the bark of each?
4. Stand some distance from each tree and look at it.
5. Pick out ash and beech trees that are some distance away. Go close to these to find out whether you are right.

LESSON: TREES

For the second lesson the teacher should have some of the following: Leaves, fruits, pictures of the trees, samples of bark, and also of the wood of ash and beech trees. The pupils' observations are discussed. The teacher tests their acquaintance with the trees by asking them to identify the samples of fruits, bark, etc.

The pupils should combine to prepare a school collection. This will contain pictures of trees, samples of leaves, flowers, fruit, bark, and wood. All the specimens from each kind of tree should be mounted on a piece of cardboard.

Tree study is a good exercise for a class excursion. The topics given above will serve to direct the observations of the pupils. More than two trees can be examined during one excursion, and sufficient samples can be collected to suffice for a review lesson.

To the Teacher: For assistance in tree identification the teacher should secure *The Forest Trees of Ontario*, King's Printer, Parliament Buildings, Toronto, 25 cents. *Native Trees of Canada* is also useful. Apply Publications Branch, Ottawa, 50 cents.

All the following trees are not found in every locality, but the teacher may select for observational study those that are most common:

Birch—Identified by the slender catkins of closely overlapping scales, the smooth bark which peels off in

strips that go around the trunk, the twigs which when chewed have a distinct "birch" taste.

Poplar—Identified by the smooth white or greenish-yellow bark of the younger branches, the bitter taste of the bark and buds, the latter usually covered with a sticky gum; the trembling leaves, the movement of which is due to the long loose stems which are in some cases flat.

Basswood—Identified by the large, heart-shaped leaves; by the bark, which is very tough and pliable, so that it is used by the Indians for making thongs and fish-nets; by the ease with which the bark slips off in spring, when a piece of branch is pounded as is done when making a whistle; and by the fruit, which is a cluster of small balls attached by a slender stem to the back of a small leaf-like wing.

Willow—Identified by the narrow shiny leaves; the long, slender outer branches covered with shiny yellowish or greenish-brown bark.

MEMORY GEM

A song for the beautiful trees,
A song for the forest grand,
The pride of His centuries,
The garden of God's own hand.

W. H. Venables

Identification of Weeds

Since the pupils of Form II cannot be expected to go very far afield in search of specimens, it is advisable to teach them to identify the weeds that are common in yards and gardens.

The selection may be made from the following list:

Pigweed or redroot, shepherd's purse, ground ivy, toad-

flax, broad-leaved plantain, also called common plantain, burdock, wild chicory, pepper-grass.

The teacher's aim should be:

1. To train the pupils to observe the characteristics of weeds.
2. To teach them to identify a few common weeds.

LESSON I: WEEDS

Type selected: redroot or pigweed.

Materials:

1. A typical specimen of the weed, having root, stem, leaves, and flowers.
2. A couple of other specimens of different sizes and not as typical in shape.
3. Several weeds of other kinds.

The type specimen is shown to the class. If no pupil can name it, the teacher gives the name and writes it on the black-board. Attention is directed to the peculiar features of the plant, as—

The height of the plant (2′—4′)

The reddish pink root

The bushy green flower clusters at the top

The leaves, dark green and rough to the touch.

After a discussion on the above features, the collection of weeds is shown to the pupils, and they are asked to find any pigweeds among them. When the correct weeds have been selected, the pupils should be required to give reasons for selecting them as pigweeds.

The differences of height, size, and branching are briefly discussed. This helps the pupils to know that slight individual differences can exist among weeds of the same variety.

The teacher informs them where these weeds may be found, and each pupil is directed to find a growing weed and to bring it to school.

Seat Work:

1. Art. Draw the weed.

2. Arithmetic. To each pupil a small portion of the flower cluster is given. By means of rubbing, the seeds are threshed out. Each pupil counts the seeds he has rubbed out. The numbers are written on the black-board. The class then finds the total number of seeds.

LESSON II: WEEDS

A brief examination of the pigweed specimens collected by the pupils is made, and questions are asked about the prevalence of the weeds and the different locations in which they are common. A weed of another kind is now shown, and the pupils are asked to tell how they know it is not a pigweed.

Let us assume that the new weed is the ground ivy. The discussion will deal with:

The small size, the almost round leaves, the round notches on the margin of the leaves, the blue flowers growing among the leaves.

The name is given and is written on the black-board.

Drill: (similar to that in the preceding lesson) follows, upon the distinctive features of the plant.

The out-of-door exercises may be similar to those on the pigweed.

When the pupils have studied a few weeds in this way, it may be found possible to deal with more than one weed in a lesson. The teacher may be guided in this by the pupils' responses in the observations and descriptions.

For information on common weeds consult *Weeds of Ontario*, published by the Ontario Department of Agriculture. (Free)

Lesson: Identification of Garden Flowers

The following garden flowers are suitable for identification in autumn: Dahlia, sweet-pea, gladiolus, nasturtium, snap-dragon, four-o'-clock, marigold, salvia, aster, balsam, pansy.

For pupils of Form II the flowers named are sufficient for two lessons. If any of these flowers are not common in the locality, they should be replaced by others that are common.

Materials:

1. Flowers of each kind to be taught during the lesson. When the flowers that are of the same kind have several colours, as in the case of the dahlia, a flower of each colour should be on hand.
2. A mixed bouquet containing representatives of all the flowers taught during the lesson.

Preparation: The teacher introduces the lesson by a short conversation with the pupils on some such topic as the favourite flower of each pupil, the flowers that each has grown in his own garden.

Pupils' Aim: To learn to know all the flowers in the gardens at this time of year.

Presentation: The teacher exhibits a flower; the colour and general form are described by the pupils. For example—the sweet-pea flower is white. It is the shape of a butterfly. The pupils should find the body and the wings. Sweet-pea flowers of other colours are then shown. The name is written on the black-board. After one or more distinguishing features of each of the three or four flowers, and their names, have been taught, the bouquet is produced, and the pupils identify all the flowers in the bouquet.

This is followed by a drill in identification and in giving reasons for answers in each case. Let each pupil select his favourite flower.

Application: After about two class-room lessons on identification, the pupils are able to undertake out-of-school problems.

Problems:

1. How many of the flowers identified in our lesson are in the school garden?

2. How many are there in your gardens at home? Bring some to school. Bring any whose names you do not know, or whose names you have found out by asking.

3. Bring flowers whose names you know, for our bouquet.

Seat Work:

Art. Draw a spray of flowers.

Spelling. Write the names of the flowers and learn to spell them.

Language. Write a description of the flowers that grow in your garden.

Literature. Read

The pansy wakes in early spring
To make our world more bright,
All summer long its sunny face
Fills children with delight.

Autumn Study of Wild Flowers

The autumn wild flowers most appropriate for identification by Form II are wild sunflowers, wild asters, and goldenrod.

The identification of the wild sunflower can be taught by making use of the pupils' acquaintance with the tame sunflower. Guide the pupils to observe the similarities.

LESSON I: WILD FLOWERS

The pupils should learn that the sunflowers and other autumn flowers have flower heads, and that each unit in the head is a flower. This can be taught as follows, without making a technical study of the organs of the flower: Supply each pupil with one of the bell-shaped units from a tame sunflower head. The teacher shows to them an ordinary bell-shaped flower, such as a gladiolus or a salpiglossis, and both teacher and pupils compare the bell-shaped parts. They also find the two kinds of small yellow bodies that are inside the tube. The pupils will now recognize that each unit of the sunflower head is a flower.

LESSON II: WILD FLOWERS

1. Wild asters of various colours.

Teach the identification of the wild aster through the pupils' acquaintance with the tame aster Although there is a great difference in size the pupils will readily see the points of resemblance. The head of the aster, like that of the sunflower, is made up of many little flowers.

2. Goldenrods of different kinds.

Note—The golden colour
The rodlike stem
The name goldenrod.

Problems:

1. How many kinds of wild asters can you find? Bring several kinds to school.

2. Be prepared to tell all the places in which you have found wild asters growing.

Similar tasks may be assigned on the goldenrod. In addition the pupils might try to find out about the useful or the harmful properties of the goldenrod.

A poet once wrote that after all the other flowers are gone,

> —on the hill the goldenrod,
> And the aster in the wood,
> And the yellow sunflower by the brook,
> In autumn glory stood,
> Till fell the frost from the cold, clear heaven. . . . .

Is it true that these are the latest flowers of autumn? Find the answer from your own observation.

Seat Work:

Arithmetic. How many flowers are there on a single wild aster plant? Each pupil counts the number in one or more heads. All add to find the total.

Art. Drawing and colour work based on the flower.

Prepare the aster and goldenrod specimens for the school collection.

ANIMAL STUDY

The Identification of Common Insects

The study of insects in autumn, by Form II, is limited to the identification of a few (four or five) common insects. This is the season for gathering larvæ and cocoons to be kept through the winter, so that the pupils may see the moths and butterflies emerging in the spring.

For the lessons on the identification of insects a selection of four or five can be made from the following list: Grasshopper, cricket, house-fly, potato beetle, lady-bird, monarch butterfly, aphis, cabbage butterfly. If any insects are causing noticeable damage to the garden or field crops of the locality, the wideawake teacher will obtain samples of these and teach the pupils to identify them.

DEPT. OF EDUCATION
HISTORICAL COLLECTION

To identify an insect implies that some of the distinctive features or habits of the insect must be observed, and a knowledge of these applied in recognizing the insect. By way of illustration, let us consider the cabbage-butterfly. The features by which it can be identified are its size, each wing being about an inch long; its colour, pale yellowish-white. Its habit of fluttering among the cabbages and occasionally settling on a leaf for a short time also assists in its identification.

The pupils should search for larvæ and chrysalids on carrot leaves, tomato vines, fences around cabbage gardens, milkweed plants, and, after the leaves have fallen, on lilac bushes and on maple and other shade trees. From these sources a sufficient number will be obtained to stock an insect cage. (See Chapter XVI.)

To the Teacher: The teacher will find the following to be very helpful as sources of information on insects. If the insect is a garden or orchard or field pest, consult the bulletins on insect pests, issued by the Department of Agriculture, Parliament Buildings, Toronto. Comstock's *Manual of Nature Study*, which should be in every school library, is a good source book on this, as on many other topics.

The insects must be identified through the pupils' observations upon living specimens. These may be collected by the teacher or by the pupils of the more advanced classes.

LESSON: THE HOUSE-FLY

The house-fly is suitable for study, because in the autumn it can be found only too easily, without looking for it.

Problems:

1. How many pairs of wings has the fly?
2. Look at the wings closely and be prepared to describe them.

3. How many pairs of legs has the fly?

4. How many pairs does it use in walking?

5. Watch the fly getting its food, and see the tube by which it sucks up the food.

OTHER INSECTS

Such an insect as the monarch butterfly can be identified by its size—it is the largest butterfly of the autumn, by its orange-brown colour, and by its wavering, fluttering flight. For observations upon the number of wings and details of colouring, a specimen must be kept in a glass vessel so that the pupils can make observations close at hand.

Specimens of the grasshopper and the cricket can be obtained under the belated stooks of grain or under loose bundles that have been left in the field, or on the barn floors among the straw and hay.

The colours of these insects, the general shape of the body, the number of legs—the large pair so useful for leaping—are points for observation. The usefulness of the brownish-green colour of the grasshopper in helping it to conceal itself among the grass, and that of the cricket for concealment in the dark tunnels in which it lives, should be discussed.

The aphids are very small insects, usually spoken of as "plant lice." They are found on the leaves of many kinds of plants. Look for them on the under surface of nasturtium leaves. A black variety is found there. On the leaves of oak and maple green varieties are frequently found. Some of these are called the ants' cows, because, when stroked by the ants, they emit a sweet fluid which is food for the ants. On the under surface of turnip leaves there is often found a green variety, which sometimes causes serious injury to the turnip plants.

The small size, the absence of wings (usually), and the conspicuous eyes are some of the features by which the various members of the aphis family may be recognized.

The Identification of Common Birds

The list given below is made up of the most conspicuous and the most common autumn birds of the orchards, fields, and roadsides of Ontario. From this list the teacher can select four or five which will be most suitable for study by his class. If the school is near a body of water, some of the birds belonging to such a location, for example, the heron, bittern, or kingfisher, may be substituted for those of this list.

Autumn birds: Blue-bird, meadow-lark, cedar waxwing, hairy woodpecker, downy woodpecker, bluejay, bronzed grackle (blackbird).

THE BLUE-BIRD

In late summer and early autumn the blue-bird may be seen in considerable numbers in all parts of Ontario, so that it is quite probable that small flocks of these attractive birds will be found in the neighbourhood of every school.

The teacher says to the class:

On my way to school I saw a flock of blue-birds. Have any of you seen birds of a very pretty blue colour?

The teacher then describes where they may be seen, and assigns the following questions:

1. Describe the blue of the blue-bird.
2. How large is the blue-bird?
3. What colour is the breast of the bird?
4. How much noise do they make?

5. These birds sing sweetly at certain times. Listen to hear their songs.

If each pupil has a slip of paper containing these questions, it makes his observations more definite.

After the pupils have had sufficient time to make their observations, a class discussion is held upon their answers.

The pupils are instructed to watch for the return of the blue-birds in the early spring. If a bird house with a very small opening ($\frac{7}{8}''$) is placed about eight feet from the ground, a pair of blue-birds may make their home in it.

Memorize:

The blue-bird's low, rich, warbled note
Spreads o'er the hill its magic spell,
While blue of Heaven that decks his coat
Tells to the world that all is well.

THE HAIRY WOODPECKER

A Tragedy of Bird Life—A True Story

There was suppressed excitement among a group of school-boys, who had paused on their way to school to watch Jim, a farm boy of the neighbourhood, shoot a woodpecker. The woodpecker was so industriously investigating the food possibilities of a clump of evergreens that grew close to Aiken's wagon shop that it was quite unaware of being the centre of a very interesting situation.

When the old muzzle-loading shot-gun had boomed, and the bird fell, fluttering in its death struggle, almost at Jim's feet, the suppressed excitement of the school-boys exploded in enthusiastic shouts of triumph.

Attracted by the noise, Hiram Wallace, the blacksmith employed at the wagon shop, joined the group now watching the last feeble flutterings of the victim. Lifting the bird from the ground, Hiram said quietly, "Boys, you have made a mistake." With his pocket-knife he opened the crop of the dead bird, and showed them the mixture of caterpillars, beetles, and fat grubs which the woodpecker had eaten for his breakfast.

"You see," said Hiram, "This bird was our little friend that had come to help us to save our fruits, and our orchard and shade trees from the insects that destroy them. Is this the right way to treat our friends?"

No boy of that group would ever again rejoice at seeing a woodpecker shot.

The bird of this story was a *hairy* woodpecker.

Here is the picture of a hairy woodpecker.

The pupils are asked to describe its colour, noting among other things, the scarlet on the back of its neck; also to describe its position when on the tree trunk.

They are told that it is almost as large as a robin.

The places where the bird may be seen are also named, and the following studies are assigned:

Problems:

1. Find a hairy woodpecker. How does it use its tail when sitting on a tree trunk?

2. How does it get the insects?

3. Find two birds that are mates. How do they differ in colour markings?

4. You may see a woodpecker that has very much the same colours as the hairy, but it is much smaller, being scarcely as large as a tame canary. This is the downy woodpecker. The downy is also a good friend to the owner or the lover of trees.

THE MEADOW-LARK

A lesson based on a picture:

Use a picture of the Mumford Series; The Perry Picture Company.

From this picture study the pupils will learn:

1. The form and attitude of the bird. Its body is short, but its legs are long, and it stands with its tail and shoulders erect.

2. The colours. The prevailing colour is dull yellow. The dark stripes on the head, the bars and spots on wings

and back, and especially the black crescent on the breast are noticeable.

3. The bird is taller and looks larger than a robin or a flicker. It can be distinguished from the latter by its height and by the absence of red on the back of its neck —a colour feature that is readily noticeable in the flicker.

The meadow-lark is one of the farmer's best friends, for it lives on insects and grubs gathered from the ground in meadows and grain-fields. It is one of the first birds to return from the south in the spring, and one of the last to migrate in the autumn. As each pair raises a family of robust children, the number of insects and grubs caught by the meadow-lark during the season to feed the young birds is very large.

The pupils are directed to look for this bird in grass fields. It is one of the largest birds to be seen there. As a person walks slowly across the field, one after another the meadow-larks will rise, each about twenty yards in front of him. With a sputtering alarm call they fly off almost in a straight line and alight about fifty yards from where they rose.

In early spring we shall watch for the meadow-lark again. Though it spends most of its time on the ground, in the spring or early summer it may be seen on the top of a fence or post, and its clear, flute-like note is one of the enjoyable sounds of the budding season of the year.

CHAPTER VI

FORM II

WINTER

PLANT STUDY

Comparison of Potato and Onion

Materials:

1. A specimen of potato and one of onion.
2. An onion and a potato each cut transversely across the centre.

Presentation: Pupils are first asked to find the points that are alike about the potato and onion, such as:

1. Both have a skin.
2. Both grow in the garden.
3. Both are good to eat.
4. If planted in the ground a new plant will come from each.

Pupils are then asked to find differences between them, such as:

1. The skin comes off the onion easily, but not so in the case of the potato.
2. The two are different in shape, the onion being more nearly spherical.
3. The onion can put out only one shoot or stem. The potato as many as there are eyes.
4. The onion is built in layers, the potato is not.
5. They have different odours and different tastes.
6. The onion is made up very largely of leaf bases, the potato is an enlargement of an underground stem.

Application: As an application of this lesson, the class should test a tulip or a hyacinth bulb, to find out whether it is more like the potato or more like the onion. Test the sweet potato also.

The potato, onion, and sweet potato make a good group for drawing.

NOTE—A green onion and a growing potato make the best materials for a lesson. By tracing the leaves of the onion downward, the pupil will find that the onion is made up of the lower parts of these leaves. An examination of the potato plant will reveal the roots and the underground stem.

ANIMAL STUDY

COMPARATIVE STUDY OF ANIMALS

In order that the pupils may be able to take an intelligent part in a lesson on the comparison of two animals, it is necessary that they have previous knowledge of certain habits of the animals. For example, the difference between the bodily features of the horse and the cow can be made to have a meaning only for those who understand the modes in which these two animals protect themselves from their enemies.

In certain instances the pupils are already in possession of sufficient knowledge of the habits of the animals, and need only a short review; in other cases it may be necessary to teach one or more preliminary lessons to give them the requisite preparation.

To the Teacher: Remembering that these lessons are for Form II pupils, the teacher must be careful to avoid observation on points too minute and on differences that are too difficult for them to interpret. Here, as in other nature study lessons, little good can come from making an observation or perceiving a difference unless the feature or difference is interpreted as having some meaning or value. Thus, to note that the neck of the horse is long and that the neck of the cow is shorter is of very little interest or value;

but the relating of these ideas to ideas upon the habits of the animals, not only exercises judgment and reason, but also tends to increase the pupils' interest in the animals, because of the new meanings they attach to their form or organs.

LESSON: COMPARISON OF THE HORSE AND THE COW

Discuss with the class the habits of these animals as follows:

1. Which can run the faster, the horse or the cow?
2. Which can keep running the longer?
3. What use does the horse make of his great speed?
4. Describe how you have seen a band of horses behave in a field when frightened.

NOTE—The horses rush away, the young colts being usually in the front of the band. All have their heads, manes, and tails high in the air.

When a strange dog or other strange object alarms a herd of cattle, how do they behave?

NOTE—They may run away, but they are more likely to come together in a group, with the older and stronger ones between the weaker ones and the enemy. They paw the ground with their forefeet and make threats with their horns.

Now we shall learn how the horse is built to save himself by running, and the cow to save herself by fighting with her horns.

Use pictures. The series—*Infant School Illustrations*, by Nelson and Sons, contains a picture of an Arab horse and another of Highland cattle. These are suitable.

Which animal seems to be the better runner?

Guide the pupils to see that the horse has longer, straighter legs and a more slender body. Compare the horse to some fast runner the pupils may know, such as any athletic boy of the neighbourhood, or a greyhound.

Discuss the suitability of the cows' horns for fighting

and also of the long, strong hind legs and hard hoofs of the horse for kicking when the enemy comes too close.

Which animal has the longer neck? Which has the stouter neck?

To teach the meaning of these differences:

When a horse is alarmed, what use does he make of his long neck? Compare this act to a boy getting up on a fence in order to obtain a better view.

How does her short, strong neck help the cow to fight?

Observe the difference between the tail of the horse and that of the cow, and also observe that the horse has a long mane while the cow has none.

How do boy scouts signal to each other? They use flags. Why does an alarmed horse raise its neck and tail high and cause the long mane to wave in the air when danger is near?

By comparing the size of the bodies of the horse and the cow, lead the pupils to see that the stomach of the cow is the larger.

Which animal, therefore, can take more food and more water?

A boy who has to run a race should eat very little. Then why is it well for the horse to have a small stomach?

Why is it a good thing for the cow to fill her big stomach as fast as possible, and then lie in a quiet place and chew her food (or cud)?

Compare the feet of the horse and those of the cow. The pupils will see that the horse has only one hoof on each foot, while the cow has a divided hoof.

To explain the value of the single hoof: What part of the foot of a good runner touches the ground? Nature has done even better for the horse, by putting him up so that he is always on the tips of his toes. Each hoof is the nail of a single toe.

Another lesson could be taken to show the use man has made of the peculiar characteristics of each kind of animal. This deals with the economic use of these animals, and should be taken in the geography period.

TOPICS FOR THIS LESSON

The slender, graceful form of the horse has been developed into beautiful varieties. The swiftness of the horse makes him useful for drawing carriages, or for giving us swift rides on his back. His hard hoof makes him capable of walking on hard ground, as in farm work. His strength and endurance make him useful for hauling loads and drawing farm implements.

The heavy body of the cow yields a large amount of beef, with only a little waste in the legs. The capacity for storing much food in her stomach makes it possible for the cow to change a great quantity of food into milk. As she is inclined by nature to take her ease while digesting her food, very little of this food is used up in movements, and the greater part is made into milk.

LESSON: CAT

Observations which will assist in the study of the cat, as a preparation for the lesson on comparison of a cat and a dog.

1. Gently scratch with a pin at some distance from where a cat is lying. What do her movements indicate?

2. Put a fish in water and watch a cat trying to get it.

3. Sprinkle water on a cat's fur, and find out why she dislikes being wetted.

4. Attach a ball to a string and move it near a cat. Describe the movements—as stalking, springing, seizing, retreating.

5. How do the short legs of the cat help it to catch birds?

6. How does a cat escape from a dog?

LESSON: DOG

Use the conversation method, since this is an animal that is well known to all the pupils. By natural, easy conversation with the pupils, encourage them to tell what they know about the usefulness and the other qualities of their canine friends.

The pupils know that some dogs are useful for hunting wild animals, others for driving or herding cattle and sheep, others for guarding their master's property, others for hauling sleighs and wagons, while others are of use as pets or playfellows.

Use pictures to illustrate the types of dogs. See *Coloured Pictures*, Mumford:

Picture of a hound, to illustrate dogs that hunt.
Picture of a collie, to illustrate dogs that herd animals.
Picture of a mastiff, to illustrate dogs that guard property.
Picture of a huskie, to illustrate dogs that haul.
Picture of a poodle or of a Pekinese, to illustrate dogs that are pets.

Discuss with the pupils the qualities that make dogs so generally useful to us. In this discussion guide the thoughts of the pupils to the qualities of faithfulness, loyalty to their friends, and docility—few animals are so easily taught. Note the dog's strength and swiftness—he can continue in a race until he catches almost any other animal. Note also his bravery—for he does not hesitate to attack an animal many times larger than himself.

Short stories of the following type may be told to illustrate the chief qualities of the dog:

THE FAITHFUL DOG

A dog was trained to guard any article that his master placed under his charge, and not to permit any one to touch it until his master gave consent. One day, when returning from the mill, the master placed a sack of flour inside the gate of a neighbour who had asked him to do so, and then continued on his way without noticing that his dog had taken charge of the sack. All through the afternoon of that day and through the long, cold night that followed, the faithful animal remained at his post.

When the owner of the sack came next morning to get it, the dog, although numb with cold and famished with hunger, would not permit him to take the flour. Nor could the stout-hearted creature be persuaded either by threats or by coaxing to desert his post until his master was brought, then, at his first word of command, the dog bounded joyfully towards him.

Conclude by a short discussion of the proper care and treatment of dogs. The dog requires a fairly warm, dry kennel, with a soft bed of straw or rugs. The food should consist chiefly of porridge, milk, bread, biscuit, and a little meat. Only dogs that are running a great deal out-of-doors should be given much meat. The dog should be given bones to pick; picking bones is as good for a dog's teeth as a toothbrush is for a boy's.

STUDY TO PRECEDE THE LESSON ON COMPARISON

By making observations upon your dog at home, find answers to these problems:

1. How does a dog hold a bone when he is picking it, and how does he get the meat off the bone?

2. Examine the dog's feet and find out:
   (1) Why does he not slip when running?
   (2) What protects the soles of his feet from injury as he bounds over the rough ground?

3. How does a dog find his master in a crowd or an object that you have hidden?

4. On which sense does he depend most?

LESSON: COMPARISON OF THE CAT AND THE DOG

For this lesson it is advisable to have a dog and a cat in the school-room, so that direct comparisons can be made.

Compare the movements of the cat when approaching her prey with the movements of the dog when chasing a squirrel.

Account for this difference.

The natural habit of the cat is to hunt alone and rely upon stealth, while dogs hunt in packs and tire their prey by chasing them and terrify them by noises.

Other differences which the pupils should be led to discover and explain are:

1. Which is the more useful to man, the cat or the dog?
2. Name uses of the dog and as many as you can of the cat.

By comparison the pupils find:

1. The cat's body is longer and more slender, and this gives her greater suppleness in crawling and leaping.
2. The cat's eye is larger, and the pupil is especially large at night. This enables her to see in a very dim light.
3. The cat's whiskers are longer; they help in guiding her at night.
4. The cat's tongue is rougher; she uses it for cleaning bones.
5. The pads on the cat's feet are softer; so that she can move more silently in stealing upon her prey.
6. The cat's claws are sharper, because she uses them for seizing her prey, while the dog seizes his prey with his teeth.
7. The cat's fur is soft. The dog's hair is coarse and stiff. Soft fur makes no noise, even the leaves it touches

are scarcely moved. The stiff hair of the dog protects his skin when he is rushing through brush and weeds in pursuit of his prey.

8. The dog is more faithful to his master because, by nature, he is a more sociable animal. In his natural state every dog is faithful to the pack and the leader; the cat is not a social animal, but it is by nature solitary and independent.

9. The dog's sense of smell is keener than that of the cat, but his sense of hearing is less keen. Account for these differences from the animals' habits of hunting. Why does the cat bring home living animals to her kittens, while the dog buries dead animals? The cat trains the kittens to approach by stealth and then to pounce on the right spot. Wild animals related to the dog bury the "kill" that is too large to be eaten at one meal.

CORRELATIONS

Language:

1. Require oral or written reproduction of the stories used in illustration in the lesson on The Dog.

2. Require the pupils to relate incidents from dog life or about pet cats which are within their own experiences.

Art and Modelling.

Draw or model:

1. A sleeping dog
2. A dog waiting for his master.
3. A cat preparing to spring upon a mouse.

LESSON: COMPARISON OF THE HEN AND THE DUCK

When they were in Form I the pupils made observational studies upon the movements and habits of the hen and the duck. A review of this should serve as a preparation for the comparative study of these birds.

While it is to be hoped that the teacher will find it possible to base the comparative lesson upon the study of living birds brought to the class room for the purpose, a good picture of each kind of bird, together with a sample of feathers from the breast of each, will make fairly good second-best material.

The following points of comparison may be taken up:

Points of agreement: Both have two wings, two legs, long necks, small heads, and a covering of feathers.

Points of difference: The body of the duck is built lower than that of the hen; hence it will rest easily on the water. The feathers of the duck are softer and more closely placed. Hence they are warmer and less easily wetted. Test by sprinkling water on the back of each bird.

The feet of the duck have webs. Hence they are useful for swimming.

The feet of the hen have long, strong toes, each toe having a stout claw. These feet are useful for scratching.

The hen sleeps on a perch. Find how the toes are placed for gripping the perch.

The duck sleeps in the water or on the ground. Find out whether its toes could grip a perch, if the bird tried to do so.

The legs of the duck are short and set far back. By nature the duck lives in the water and does not walk much. The legs are in the right place to be used as paddles.

The legs of the hen are long and strong. Hence they are useful for walking and for scratching.

The beak of the duck is shaped like a long, narrow shovel. Hence it is useful for gathering food from the

water. Watch a duck getting food off the ground. Compare its method with that of the hen.

The beak of the hen has a hook at the end for catching the grains and insects at which it pecks.

CORRELATIONS

In Clara D. Pierson's book, *Among the Farmyard People*, there is a very good story entitled "The Duckling Who Didn't Know What to Do."

The pupils may read this for a supplementary reading lesson.

The teacher may use the story for a language lesson.

CHAPTER VII

FORM II

SPRING

ANIMAL STUDY

Identification of the More Common Birds

In the spring the pupils of Form II should renew their acquaintance with the birds they have previously learned to identify. These will include most of the following:

Robin, blue-bird, meadow-lark, flicker, bronzed grackle, hairy woodpecker, and crow.

Interest in this work will be increased by the making of a bird chart in which the pupils record the facts about the return of the birds. The chart may be made on a black-board at the side of the room, and the entries added to from day to day. Each pupil should make a chart in which to record his own observations in his note-book.

> Hast thou learned to know the birds without a gun,
> Loved the wild rose and left it on its stem?
> Then be my friend.

Name of bird	Earliest date	Where seen	First observer
Robin.....	April 5th.....	Orchard tree....	Jack Reid
Blue-bird.....	April 9th.....	Roadside fence..	Will McFee

In addition to the recognition of old acquaintances, the pupils who are on the watch for birds will be

attracted by some of the following: Song sparrow, slate-coloured junco, American goldfinch, red-winged blackbird, phoebe, wren, cowbird, vesper sparrow, and oriole. These are all conspicuous in the spring, some because of their bright plumage, others because of their sweet songs, while several attract attention by both their colour and their song.

It can scarcely be expected that all the birds on this list will be studied by the Form II pupils of every school, but the teacher of any class can so direct the observations that three or four of these birds will be identified during the spring.

The method outlined for the identification of birds by Form II in the autumn, is, of course, applicable to the study of birds in the spring.

Some special information and suggestions are given here that will assist in directing the observation work on specific birds.

THE SONG SPARROW

In early March, when the streams are just beginning to break from underneath the ice and spots of ground peep here and there through the snow, assign to the pupils an exercise such as the following:

Watch for a small gray-brown bird which perches near the top of a bush or small tree, and sings the "Tea-kettle Song." The teacher should tell the pupils where he has seen and heard such a bird quite recently.

Try to interpret the song in the words:

"Maids! Maids! Maids! Put on the tea-kettle, tea-kettle, tea-kettle, tea-kettle, tea-kettle-ettle."

Listen to the song. How does the bird feel? How often does he sing this song?

Approach close to the bird. Describe its spots and stripes, and its colours. Describe the flight of the bird.

To the Teacher: It is possible for the pupils to distinguish the song sparrow by means of the exercises given above. It is one of the first birds to return in the spring, and, as it is a lusty singer, it will attract the attention of all who are looking for birds. The dark brown spot in the centre of the breast is a distinguishing mark, and the more observant will find the three ash-gray stripes on its head and the dark line through the eye.

When disturbed it does not rise, but flies downward and disappears with a swish of its tail. The nest is usually built on the ground or in a low bush or tree. It is composed of grass, fine roots, or weed stems, and is lined with fine grass or hair. The number of eggs is usually four or five, but sometimes there are as many as seven. They are white, with a greenish-blue tint, and are closely spotted with brown.

CLASS ROOM LESSON

Discuss with the pupils the observations that they have made when doing the above field work.

Generalize as to the similarity of the places in which the pupils have seen the sparrow while it was singing, and as to the times of day at which the bird sings.

Teach the marks of identification which some have discovered, using for this purpose pictures of the bird and also black-board drawings. Encourage those who have not yet seen the song sparrow to try again, and to secure the assistance of those who have succeeded.

Compare the size and the song of the song sparrow with the size and the song of the house sparrow (English sparrow).

Tell the pupils the great value of the bird for killing cutworms, plant-lice, caterpillars, ground beetles, grasshoppers, flies, and other insects. It also helps to prevent the spread of weeds by eating thousands of seeds of noxious weeds.

Assign to the pupils some other things to discover: Through how many months of the summer does the bird

sing? Find the nest. Why is it hard to find? Describe the eggs, as to colour, size, and number.

Do not disturb the nest and do not visit it too often.

THE SLATE-COLOURED JUNCO

Look for this bird along fences. It frequently builds its nest on the sheltered part of a rail. In early spring it is also seen around the dooryards picking up crumbs.

This is one of the gentlest and most industrious, in a quiet way, of all our birds. It delights to live where man is carrying on any kind of forest or farm work, but its whole attitude indicates a wish to go quietly about its own affairs.

Look for a slate-gray-coloured bird, smaller, or at least shorter, than a common sparrow. In the spring the slate-gray so nearly approaches a blue that poor observers have been known to mistake this bird for the blue-bird. The breast of the junco is light gray, not reddish like the breast of the blue-bird. The feathers along the side of the tail are white. The chirp of the junco is a faint metallic sound somewhat resembling that which is made by striking two small stones together.

THE AMERICAN GOLDFINCH

This is the bright sulphur-yellow-coloured bird with black wings that is commonly called the wild canary. Its beauty and its song are both attractive. It is a great favourite with farmers and gardeners, for it consumes large numbers of weed seeds.

The female is clad in more sober tones of yellow and gray.

The nest, which is usually built in a shade tree or an apple tree, is a dainty structure lined with very soft material.

THE RED-WINGED BLACKBIRD

The red-winged blackbird may be seen where cat-tails grow along the edges of a stream or a pond.

Prepare the pupils to recognize this bird by showing them a picture of the bird. The Mumford picture shows the colours quite clearly.

THE ORIOLE

The Baltimore oriole is another bird which can be readily identified after a short picture study. This bird is somewhat smaller than a robin. Like the robin it visits the trees around our homes. Its whistle is louder and clearer than that of the robin.

OUTLINE LESSON I: THE ROBIN

Time: Month of May.

Method: During a short lesson (five minutes), by means of a story about the robin, by the study of a verse, by a review of the lesson given in Form I, or by a conversation with the class, the interest of the pupils is aroused. They are then instructed to watch for robins that are moving in pairs, and report where these may be seen.

Verse suggested for discussion:

> And now Robin Redbreast comes back with the Spring,
> On the high tree-tops he'll whistle and sing.
> He knows everybody is happy to see
> Both him and his mate on her nest in the tree.
>
> *Nature Study and Related Literature*, McGovern

Questions: Why does Robin Redbreast make us happy?

Which bird builds the nest? How does he help in the building?

How are the young robins fed?

We shall now take up a study of the robins and their nest and young, to learn more correct answers to these questions.

Problems are then assigned to the pupils as a guide to their observation work.

The following are suggested for the first exercise:

EXERCISE I

1. Learn to know the father bird. His beak is more yellow than that of the mother bird, his breast is brighter, and his back is darker.
2. Watch the birds building the nest. Which bird carries the materials?
3. What are the materials?
4. Where do the birds get these materials?
5. Which bird shapes the nest?

During the week between the assigning of these problems and the second nature study lesson on the robin, the pupils make observations. They record their observations in note-books. The notes will also include drawings and dates of observations.

LESSON II: THE ROBIN

The second lesson should consist of a comparison of the results of the pupils' observations. The observations will probably be imperfect in many instances. In case any observation is quite wrong, it is advisable to ask the pupils to try again, so that they may make a better one. When the observations are correct, they should be recorded in the permanent Nature Study note-books. When the study of the robin is complete, these notes

should contain, in addition to the written descriptions, at least two drawings. These should show some of the following things: The full grown robin, the nest, the surroundings of the nest, a young robin just after leaving the nest.

When the first set of problems has been disposed of, the following should be given as a second exercise:

EXERCISE 2

1. Is it the father bird or mother bird that sings?
2. Where is the other bird when one is singing?
3. Do both birds sit upon the eggs?
4. Are the eggs ever left uncovered? For how long?
5. How are the nest and the birds shielded from rain?

The second exercise should be dealt with in the same way as the first; and, after it has been satisfactorily completed, the problems for the third exercise may be given to the pupils, and after it a fourth exercise in due time.

EXERCISE 3

1. What do the young birds look like at first?
2. How soon are they covered with feathers?
3. Are their eyes open at this time?
4. Do both parents carry food to the young?
5. How do the young birds tell the parents that they want food?
6. What things are brought to serve as food?
7. Where do the old birds get these things?

EXERCISE 4

Problems:

1. How old are the young birds when they leave the nest?

2. How do they differ in colour from the old birds?

3. How do the young birds get food after they have left the nest?

4. Describe their first flights.

5. What enemies have they?

The teacher should encourage the pupils to make observations outside the range of these questions. Questions should be asked to stimulate the pupils' imaginations, such as:

1. Try to express the robin's song in words.

2. Why does the robin sing to his mate?

3. What feelings has the mother bird when the young ones leave home?

When the pupils have solved the problems in any one of the above Exercises in a fairly satisfactory way, stories should be told to them or read by them, to show what other observers have seen when they have studied similar problems upon the robin.

NOTE—The teacher will find the necessary information on this subject in *Manual of Nature Study*, Comstock, and also in *Birds of Ontario in Relation to Agriculture*, Nash; Department of Agriculture, Parliament Buildings, Toronto.

THE LIFE HISTORY OF THE FROG OR THE TOAD

About the middle of April when the ice is gone from the small ponds and streams, the teacher should set his nature study scouts watching for the nesting places of frogs and toads. The ponds from which the music of frogs and toads arises is the best place to make the search. The frogs' eggs are inclosed in masses of jelly, which are attached to weeds and float near the surface of the water. The eggs of the toad are laid from one to two weeks later than those of the frog. These are incased in long strings of jelly. The strings are coiled around weeds and other

objects in the water, and the eggs are in this way prevented from being carried away by the movements of the water and from settling into the mud at the bottom of the pond.

Transfer the jelly and eggs of the toad (or the frog) to a pan of water, and keep this in a fairly warm place.

The pupils should make observations upon this material in a class lesson.

The place from which it was brought is described. The pupils are told that these are toads' eggs.

1. What shape are the eggs?
2. What colour are they?
3. Describe the colour of the jelly.
4. Describe the length and thickness of the strings of jelly.

Problems:

1. Look at the eggs once every day. Is there any change in their size or shape?
2. Do the young tadpoles move while they are in the eggs?
3. Can you tell which end is going to be the head and which the tail? Give reasons for your answer.
4. Watch how the tadpoles make their way out of the jelly.

In the next lesson the pupils will tell what they have observed when working out these problems.

When the tadpoles have hatched, return all but about a dozen to the pond, and place the rest in an aquarium. (See Chapter XVI.) To make this comfortable for the young tadpoles it should contain stones and mud or leaves from the bottom of the pond, and should be filled with water also taken from the pond. The tadpoles will get food from the minute plants that grow in an aquarium

prepared in this way. A few small crumbs of hard-boiled egg should be put into the water occasionally, and a piece of tulip leaf with the skin peeled off one side, if placed in the water, will also furnish food for the tadpoles.

Problems for the study of the growing stage:

1. Look for the little fringes on the side of the neck. These are the gills. They soon disappear.

2. Describe how the tadpoles swim.

3. When they are at rest, how do they keep their place in the water?

4. Describe the eyes of the young frog.

5. Compare the mouths of the tadpoles of frogs and toads.

6. Which pair of legs comes out first?

7. How long is it after the first pair of legs comes before the other pair appears?

8. What changes take place in the tail while the legs are growing?

9. When does the tadpole begin to use the legs for swimming?

Seat Work:

Art. Make a drawing of the aquarium, showing the masses or strings of eggs and also the young tadpoles.

Composition. Write the story of the life of the tadpole.

THE LIFE HISTORY OF THE TOAD

In April when the ice has melted from the waters, toads travel long distances to their favourite nesting-places in the ponds and streams. From such ponds and streams there arises, about the middle of April of each year, the thrilling chorus of a toad choir. A score of the joyous singers can be counted from the bank of many a pond. In the closing days of this month long strings of eggs, like necklaces of tiny black beads, may be found coiled among tufts of

weeds and submerged sticks in the shallow water. The eggs are scarcely larger than pin heads, and a toad may lay as many as twelve thousand in a single season.

The length of time required to hatch the eggs by the warmth of the water and the energy of the sun varies with the weather. Under favourable conditions four days after the eggs are laid the young tadpoles are out clinging to water weeds. They appear to cling by their chins, but in reality they cling by means of a disc-shaped sucker which is below the tip of what corresponds to the chin.

By July the tadpoles have almost changed into baby toads. The four legs have all come out, and the tail has become quite small. The young toads soon begin to take daily land exercises at the margin of the pond. The final departure from the water in search of homes on land usually takes place on a rainy day. On such a day the atmosphere is well-suited for making the transition. The great number of baby toads that are sometimes seen during such an exodus has probably given rise to the belief that toads fall from the clouds during rainstorms.

Toads do not return to the nesting-pools until they are three or four years old. How marvelous is the instinct that guides them after this long interval to the waters in which they had their birth! The toad is called an amphibian, because it is fitted for living both on land and in water.

NOTE—Though it is very much better that the nature study work on the life history should be observational work such as is outlined above, if the teacher fails to obtain the necessary material, the lesson may be taught in story form. Pictures representing the different stages in the life history can be used to illustrate the story.

THE BUTTERFLY

In the spring the Morning Cloak, Eastern Swallowtail, and other butterflies may be seen in considerable numbers. The teacher should secure a living specimen and keep it in the school-room in a cage or glass jar. A day will be long enough to keep it in order that the pupils may make their observations. The insect should then be given its liberty. Its life is a short one.

Type: Eastern Swallowtail. If the class has had an insect cage containing cocoons, the butterfly that has just emerged will arouse interest without any effort of the teacher; but if the specimen has been secured in

some other way, prepare the pupils for the lesson by arousing their interest in the beauty of the butterfly. This may be done by telling a short story.

THE PANSY BUTTERFLY

One day a little girl was out in the garden gathering pansies. She was a wee little girl and loved the flowers because they were so beautiful. She reached out her tiny hand to pull a flower that looked even prettier than any of the others, but, just as she was about to touch it, the flower rose up and flew away. "Oh! Mother! Come quickly," she cried. "Here's a pansy that has wings."

This is a butterfly like the one the little girl saw. What made her think it looked like a flower?

Observe:

1. The large wings—four of them
2. The beautiful blue and yellow and orange-brown colours on the wings
3. The slender, graceful form of the body, with its gold lines
4. The long, slender feelers with knobs at the end projecting in front of the insect
5. The rhythmic movements of the body and wings
6. The six long, slender, graceful legs
7. The long "tongue," coiled like a spring. Perhaps if you put into the cage a flower with sugar and water in its centre, the "tongue" will uncoil, and the children may see how the butterfly feeds from flowers.

If a moth can be secured for study at the time the butterfly is being studied, a few of the points of difference should be learned by comparison.

Examples:

The body of the moth is stout or fat.

The feelers of the moth are feather-form.

The body and wings of the moth have a thicker covering of down and scales

Seat Work: Paper cutting, to represent the moths or butterflies.

Drawing and colour work. Do not ask for much detail.

Reproduction of the story told at the beginning of the lesson, (1) in words, (2) by a drawing.

Out of school problems:

1. How many kinds of butterflies can you see?
2. Where are they seen among the flowers?

Plant Study

THE DANDELION

Some days before the lesson is taught out-of-doors, exercises are assigned to the pupils:

1. Look for dandelions, find where they are most common, and bring to school some flowers and leaves of the plant.

2. Look at the dandelion flowers in the grass when the sun is shining brightly, and again in the early morning or the late evening.

3. Watch the flowers of the dandelion on a sunny day and find what insects visit them.

Materials: Each pupil is provided with a flower and a leaf of the dandelion. One plant with root, flower, and rosette of leaves is brought from a lawn and another from a plot of long grass. A few extra leaves and flowers and some seed globes are at hand.

Preparation: Where did you find dandelions growing most commonly? Why was it not common in the cultivated parts of the garden? In general it is found most abundantly in grassy places where the soil is not disturbed.

Problem: Let us try to get better acquainted with the dandelion.

Presentation: Place a flower and a leaf of a dandelion together. Which has the brighter colour? What is the colour of the flower? These flowers beautify the roadsides in spring and make people happy.

What kinds of insects did you see on the flowers? What did they seem to be doing? The bees get from the flowers a sweet liquid called nectar, from which they make honey. They also get a yellow powder called pollen, which they feed to the young bees before their wings appear. In going about they scatter pollen from flower to flower, and this pollen causes the flowers to produce seeds. Why does the dandelion need to have such brightly coloured flowers?

Smell the flower. This odour also attracts bees. When you observed the dandelion out-of-doors, were the flowers open wide all the time? When are they not open? Bees do not fly much when the sun is not shining. At night and during the dull weather the flowers remain closed, perhaps for protection.

With a ruler each pupil measures the width of a head. Are the heads all of the same size? Each pupil measures the length of his flower stem and reports his finding. Are all stems of the same length? Examine the stems of flowers from a lawn and compare them with those taken from long grass. Which are the longer? Why does the flower in the long grass need a longer stem than that which grows on a lawn?

The children break open the heads of the flowers and see the separate parts. They are told that each part is a little flower or floret, which produces a seed. The whole cluster is called a *head*. What do we find around

the outside of the head of little flowers? When the head is open, do we see these green leaves readily? When the head is closed, where are these leaves found? They protect the head.

Here is a head that is withered. Why do not the bees visit it? Its colour has faded, and bees no longer visit it. Now a great change takes place. In a few days the head opens again, but this time it is white with age like this one. (Teacher holds up a seed globe.) Let us blow into this beautiful, round, white head. What happens? Thus the wind carries away the little children of the old dandelion, and they settle down and grow in other places. What is the advantage of seed scattering? The children examine a plume with the seed attached. Several pupils make drawings on the black-board. How do the stems of these ripe heads of the dandelion compare with those of the flowers in full bloom? How is the long stem useful in scattering seeds?

A whole plant is held before the class, and the pupils see at the base of the flower stalk the broad, green leaves. What shape are they? What is peculiar about the margins? From the appearance of these jagged teeth the plant gets its name (dent de lion, tooth of the lion). What position do the leaves take? This rosette of leaves enables the plant to get the sunlight which it needs, and prevents other plants from shading it too much by growing too close to it. How will these leaves affect grass on a lawn? How do gardeners like dandelions?

Below the leaves we see the root which was buried in the soil. What is its colour? Describe its shape. What does the root do for the plant? Tell why it is not easy to pull a dandelion. The root lives through the winter and contains food with which to send up flowers early in the spring. When do dandelions bloom? If they

had to grow from seeds in the spring they could not bloom so early.

Application: Individual children are asked to relate, in parts, what has been learned about the dandelion.

Seat Work:

1. Make a drawing of a dandelion plant, showing the root, leaves, flower head, and seed ball.

2. Make separate drawings of the following: (1) A leaf, showing its shape and teeth, (2) a seed attached to its plume.

3. State as many reasons as you can why the dandelion grows well in grassy places.

4. Make a list of the different uses of dandelion flowers to the plant and to man.

CHAPTER VIII

FORM III

AUTUMN

ANIMAL STUDY

Observations on Common Insects and the Study of Their Life Histories

There are two butterflies, the cabbage and the monarch, whose larvæ are easy to obtain and whose stages of development occupy only part of a single season. For these two reasons these butterflies make suitable specimens for the beginners in insect study.

The larva of a third butterfly, the Eastern Swallowtail, is also easily obtained; but as the winter is passed in the chrysalis stage, it is for this reason somewhat less suitable.

As soon as nature study lessons are begun in the autumn term, the pupils should be instructed where to find the larvæ of at least one of these three butterflies.

The larva of the cabbage butterfly is the green worm that feeds on the leaves of cabbages and cauliflowers.

The larva of the monarch butterfly feeds on milkweed plants. It is a large green worm marked with black bands. This coloration helps to conceal it, for the green harmonizes with that of the plant, and the black breaks the mass into parts.

The larva of the Eastern Swallowtail feeds on the leaves of carrots, parsley, and parsnips.

THE CABBAGE BUTTERFLY

Transfer a few of the largest cabbage worms you can find, together with pieces of cabbage leaves, to the insect cage in the school-room.

Observation exercises on the larva:

1. Describe the shape, length, and colour of the larva.
2. Which end is the head? Find its eyes, feelers, mouth?
3. How many legs has the larva? Only the first three pairs of legs will remain as legs in the mature insect.
4. What parts of the leaf does it bite?
5. Make a drawing of the larva and record the date of passing into the pupa or chrysalis stage.

Observation exercises on the chrysalis:

1. Compare the thickness of the chrysalis at the two ends.
2. Of what sort of material is the case of the chrysalis made?
3. How is the chrysalis attached to the support?
4. Make a drawing of the chrysalis and record the date of the emergence of the butterfly.

Observation exercises on the adult:

1. Describe the size and colour.
2. How many wings and how many legs has the adult?
3. Find the feelers and the tube by which it sucks food.
4. Make a drawing of the adult butterfly.

To the Teacher: The adult cabbage butterflies are almost white, with a slight yellowish tinge. There is a dark brown spot at the tip of each forewing. In addition to this spot, the male has a single brown spot on each wing, and the female has two spots on each.

When the larva is mature, it leaves the cabbage plant and seeks a sheltered spot in which to spend the chrysalis stage. The chrysalis is usually found under the top board of a fence or the edge of a projecting board of a building.

The chrysalids formed in early summer develop into the adult form during that season. Those formed in late summer may not complete their development until the following spring.

THE MONARCH BUTTERFLY

Observation exercises on the larva:

1. Describe the larva under the headings—(1) colour, (2) shape, (3) size, (4) stripes or bands, (5) projections from its body.

2. Try to discover the use of the lash-like projections.

3. Make a drawing showing the larva, and record the date of passing into the chrysalis stage.

Observation exercises on the chrysalis:

1. Describe the chrysalis under the following headings—(1) size, (2) shape, (3) colour, (4) colour of markings and the arrangement of these, (5) how the chrysalis is attached to the support.

2. Make a drawing of the chrysalis, and record the date of the emergence of the butterfly.

Observation exercises on the adult:

1. What is the width of the butterfly when its wings are outspread?

2. Describe the colour of the wings, including the colour of the lines along the veins and the colour of the spots near the margins of the wings.

3. Name all the parts of the insect that are black.

4. Make a drawing of the butterfly.

Set the butterfly free after completing the study, for it is a beautiful and harmless insect.

To the Teacher: The monarch is one of the largest butterflies that we have. It is frequently known as the milkweed butterfly. Its colour is brown and yellow-brown, with black lines along the veins and dark margins around the wings. In the dark margins there is a double row of light spots.

The larva is green with black bands. A pair of fleshy filaments that wave vigorously when the larva is agitated is found near the front end.

The chrysalid is of a beautiful pale green colour marked with rows of golden spots. It is fastened to the supporting object. For some unknown reason neither the adult, the larva, nor the pupa is palatable to birds.

EASTERN SWALLOWTAIL BUTTERFLY

No butterfly is more suitable for study by the Junior Forms than the Eastern Swallowtail. It is one of the most beautiful and attractive of our butterflies and lays its eggs so accommodatingly on every carrot, parsley, or parsnip bed that it gives ample opportunity for observation.

The large yellow and green larva with fierce-looking head may be found in these places.

In March or early April the full-fledged butterfly emerges from the chrysalis.

PLANT STUDY

The Identification of Weeds

In these lessons the teacher's aim should be:

1. To teach the pupils to identify the weeds.

2. To help them to understand how the weeds can be controlled.

Each of the four lessons outlined below deals with four kinds of weeds. The four kinds taken up in each lesson have the same means of persisting or of spreading. This grouping will help the pupils to remember the most important facts about the weeds.

LESSON I: WEEDS

Weeds: Pigweed, ragweed, lamb's quarters, foxtail.

Materials: A typical specimen of each plant, several specimens less typical of each plant.

Preparation: A short conversation upon the harmfulness of weeds, leading to the question—How can weeds be prevented from increasing?

Problem: To learn to identify these four weeds, and the means of prevention of these weeds.

Presentation: The typical specimen of pigweed is shown to the class, the name is obtained or given by the teacher, and is written on the black-board.

In order to know this plant when we see it again, we must notice some of its peculiarities.

The red colour of the root is noted, also the bushy top filled with seeds. The seeds are the only means by which this plant can multiply, so if we destroy the weed before the seeds form, that will be the end of it.

A second weed is dealt with in the same way.

NOTES: Characteristics of the ragweed are the deeply-cut leaves, the low, broad form of the plant, the small, loose clusters of flowers or fruits.

Characteristics of the lamb's quarters are the whitish colour of the plant, the mealy surface, the irregular balls containing seeds.

Characteristics of the foxtail are the grass-like leaves and the foxtail-shaped head filled with seeds.

Using the collection of specimens test the ability of the pupils to identify the weeds. All the weeds studied to-day can be spread only by their seeds.

Application: Each pupil is required to bring to the class a specimen of each of the four weeds studied,

together with a short written account of where they were found.

Example: I found the pigweed growing in a cornfield.

I found the ragweed growing in a pasture field.

Seat Work:

1. The pressing of specimens of weeds and the making of a school collection. The best work goes into the collection.

2. The identification of weeds by means of the pictures given in weed bulletins, such as *The Weeds of Ontario*, published by the Department of Agriculture, Parliament Buildings, Toronto.

LESSON II: WEEDS

Method: Similar to that of Lesson I.

The weeds of this group reproduce by seeds only; but these seeds are capable of retaining their vitality for many years when buried deep in the ground. After lying dormant for years, upon being brought near the surface by the processes of cultivation, the seeds will germinate. For this reason it is very difficult to exterminate these weeds, and, accordingly, very great care should be taken to destroy the weeds before their seeds are nearly ripe.

Weeds of this group are: Common wild mustard, wild oat, ox-eyed daisy, purslane. The last plant will mature its flowers and seeds even after it has been pulled from the ground.

LESSON III: WEEDS

Method: Similar to that of Lesson I.

The weeds of this group reproduce not only by seeds but also by peculiar parts that spread out under the ground. These are not roots, but are underground stems.

Each joint of this underground stem may produce a new plant. This makes the members of this group very difficult to eradicate, so that it is wise to learn to recognize these weeds and destroy them before they become well established in the fields.

Weeds of this group are: Perennial sow thistle, twitch grass, Canada thistle, sheep sorrel.

The teacher can make a selection of the outstanding features of these plants.

LESSON IV: WEEDS

Method: Similar to that of Lesson I.

The weeds of this group reproduce by seeds and also grow from their very stout (tap) roots.

Weeds of this group are: Burdock, curled dock, dandelion, wild carrot.

The weeds that are given on the above lists are, for the most part, intended to be suggestive. Those that are not found as common pests in a locality should be replaced by weeds that are common to that locality.

If groups of four weeds in a lesson are considered too large, they may be reduced to groups of three or two.

Since Form III has also to study weed identification, the classes of Forms II and III may be combined for all or part of the work on this topic. This will provide a review for Form III of the weeds taken while in Form II.

Bulb Planting

The planting of bulbs in pots for winter blooming should be commenced with pupils in Form II and continued in the higher Forms. As a rule the potted bulbs will be stored and cared for in the home, as most

school-rooms are not heated continuously through the winter. Paper-white narcissus and hyacinths are most suitable, and should be planted about the fifteenth of October so that the plants may be in bloom for Christmas. Hyacinth, tulip, and daffodil bulbs planted in October will bloom at Easter, or earlier if required.

LESSON: BULBS AND PREPARATORY BULB PLANTING

Materials: The bulbs to be planted.

As many four-inch flower-pots or tomato cans as are required.

Soil, composed of garden loam, sand, and well-rotted manure in equal proportions. Stones for drainage.

Sticks for labels. (Smooth pieces of shingle, one and a half inches wide and sharpened at one end will answer.) Pictures of the plants in bloom.

Observations: The attention of the pupils is directed to the bulbs, and they are asked to describe the size, form, and colour of each kind of bulb.

A bulb is cut across to make possible the study of the parts, and the pupils observe the scales or rings. These are the bases of the leaves of the former plant from which the bulbs grew. The use of the fleshy mass of the bulb as a store of food for the plant that will grow from it is discussed.

The sprout in the centre of the scales, with its yellowish-green tip, is observed, and its meaning inferred.

The picture is shown to illustrate the possibilities within the bulb.

Planting the Bulb: The teacher directs the work which is done by the pupils, and the reasons for the operations are developed.

1. What is the use of the one-inch layer of pebbles, or broken brick, or stone, that is placed in the bottom of the pot?

2. Why are the bulbs planted near the top of the soil?

3. Why is the soil packed firmly around the bulbs?

4. Why must the soil be well wetted?

5. Why is the pot set in a cool, dark place for a month or more?

To the Teacher: The pebbles or broken brick are for giving drainage. The bulbs are planted with their tips just showing above the surface of the soil, and there is about half an inch of space between the top of the soil and the upper edge of the pot in order to facilitate watering. The potted bulbs must be set in a cool, dark place until they are well rooted. This is subjecting them to their natural winter conditions, and it will cause them to yield larger flowers, a greater number of flowers, and flowers that are more lasting. Sand in the soil permits the air to pass more freely through the soil. Basements and cellars are usually suited for storing until the bulbs have rooted, but they must not be warm enough to promote rapid growth. The pots when stored may be covered with leaves, sawdust, or coarse sand to prevent drying out, and to prevent the roots from pushing the bulbs out of the pots. The soil must be kept moist but not wet. Paper-white narcissus, if brought out of the dark after three or four weeks, will be in bloom at the end of another month, if kept in the window of a warm room. Care must be taken not to expose the plants to bright light until they have become green. The bulbs of the white narcissus are to be thrown away after the flowers have withered, as they will not bloom again, but freesia bulbs may be kept and planted again the following year.

The time of the flowering of hyacinths, tulips, and daffodils can also be controlled by keeping the developing bulbs in the cold basement until a few weeks before the flowers are required.

If there is not a basement suitable for storing the potted bulbs, a very good substitute is a hole dug in a dry part of the garden. Set a box into the hole, place the pots in the box, and cover it with boards, leaves, or straw, and, as the weather gets colder, cover with soil.

Chinese sacred lilies and hyacinth bulbs may be planted in flat vessels containing pebbles and water. Keep the water about one-third of the way up the bulb.

CARE OF PLANTS IN THE HOME

Plants usually need re-potting once a year. Many kinds may be set out-of-doors in flower beds in May and

left until September, when they may be taken up and placed in pots, or cuttings may be made from them for potting.

A flower exhibition at the school once or twice a year, or at a local exhibition, adds to the interest.

The pupils should report to the teacher the progress of their plants and make many drawings showing their development.

PLANT CUTTINGS

The pupils will be interested in learning that it is possible to produce new plants without waiting for them to grow up from the seed. It will indeed be quite a surprise to them to see a new plant complete in all its parts grow up from a small piece of stem, root, or even leaf. With a little care children may propagate plants in this way.

SELECTION OF CUTTINGS

Begin with some of the common herbaceous bedding-plants, such as geranium, coleus, or fuchsia. These are such common bedding-plants that they are easily obtained in the autumn. Only well-matured stems of the season's growth, such as will break with a slight snap when bent, should be used.

For the lesson the pupils should provide themselves with sharp knives, with small boxes or pots, and with some moist, clean sand—not potting soil. A few holes should be bored in the bottom of the box, then a layer of fine gravel put in to provide for good drainage, and over it layers of moist sand. Take a slip or growing end of a stem about three inches in length, always cutting it at or just below a node, or joint, and leaving only a couple of small leaves on the top of the slip. Insert it to about half its depth in the box of moist sand. These cuttings

may be placed a few inches apart in the box, which should then be placed in a warm, light room for a few weeks until the roots develop. The cuttings should be partly shaded by papers from the strong sunlight, and the sand kept slightly moist but not wet. Bottom heat and a moist, warm atmosphere hasten their development.

Another convenient and very successful method of starting cuttings is to take a six-inch flower-pot, put two inches of fine gravel in the bottom, set a four-inch unglazed flower-pot in the centre, and fill up the space around it with sand and garden loam, mixed. Put a cork in the hole in the bottom of the small flower-pot, and then fill it with water. Put the cuttings around in the space between the two pots and set in a fairly warm room in a moderate light.

POTTING OF ROOTED CUTTINGS

When the cuttings are well rooted, which requires from three to six weeks according to the variety and growth conditions furnished, they should be carefully lifted and transplanted into pots or boxes where they will have sufficient room to grow.

ANIMAL STUDY

Habits and Adaptive Features of Common Birds

THE WOODPECKER

Woodpeckers can be approached closely enough to observe a number of their characteristics and some of their structural features. For this reason this bird should be studied in field observations.

Problems to guide the pupils in their observations:

1. How does the flight of the woodpecker differ from that of other birds?

2. How does it differ from other birds in its manner of sitting on a tree?

3. What use does the bird make of its tail while sitting on the tree?

4. Find out why woodpeckers peck at trees.

5. Is it true that they hammer more on the trees in the spring than at other times of the year?

(One boy, who has been observant of the habits of birds, has asserted that in the spring, the male drums on any object which will give a loud sound, such as a hollow tree or a loose board; and that the drumming is to tell his mate where to find him, when she has returned from the south. This boy also says that the same woodpecker returns every spring to a telephone pole opposite his window. For about a week the bird beats such a lively tattoo every morning at sunrise that it is impossible to sleep. As soon as the mate arrives the drumming ceases for that season.)

Closer observation of the bird will reveal how the woodpecker is fitted for its usual occupations.

6. How does the shape of the body help the bird to rest on the side of a tree? Which form is more suitable for sitting on a tree trunk? (Note the flat form of the body.)

7. Compare the width of the shoulders with the width of the rest of the body.

8. Describe the beak. Show that the form of the beak is fitted for pecking holes in wood.

9. Find what the tips of the tail feathers are like. How does this form help the bird to sit on the tree trunk?

10. Describe the length of the neck.

It may be necessary for the teacher to use a picture or specimen to aid the pupils in discussing these questions, since it is difficult to see the features in field observations.

THE OWL

It is seldom possible to have a living owl for a class specimen. Occasionally one is captured in a barn in the winter time, or the little screech owl is sometimes caught napping in an orchard on a bright, sunny day. Even if he awakens his eyes are dazzled by the light.

As the owl is a nocturnal bird, few school children ever have an opportunity of seeing one or of observing its habits, though many may have heard its melancholy "Whoo whoo" in the stillness of the night.

A picture which shows the parts of the bird clearly may be used in the class. It should be possible to distinguish in the picture the following features that fit the bird for killing and eating animals, including birds:

1. The broad shoulders, short neck, and large, round head. These parts are strong in order to enable it to kill and tear its prey.

2. The strong, curved beak. The shape is a guarantee that anything that has been seized by this beak has very little chance of escape.

3. The long, strong, curved claws are shaped for seizing and holding the victims.

The picture will also show certain features that fit the bird for its nocturnal life:

1. The erect attitude. It has to watch and listen closely in the night for its prey.

2. The large eyes with wide-open pupils resembling those of a cat. The large eye takes in enough light to

enable the bird to see in a very dim light. In the daytime so much light enters that the eye is dazzled.

The picture will not show the following features that fit the owl for nocturnal life:

3. The softness of the feathers. This gives to the bird such a noiseless flight that it is able to swoop upon its prey without being heard.

4. The very acute sense of hearing enables it to hear the rustle of a squirrel or of a mouse as it scurries over the fallen leaves of the forest, while the owl is perched on the top of a tall tree some distance away.

Let us hope that some keen-sighted pupil of the class will discover the home of a screech owl. This tiny owl makes its home in the hollow limb of an old orchard tree or in the abandoned home of a woodpecker. There the family of little owls is reared, perhaps as many as six of them. How industriously the parents must work all through the night, catching moths, and beetles, and bugs, and mice, to feed such a large and hungry family! Think of the valuable service these birds must do for the farmer and the gardener, by destroying large numbers of pests that attack the vegetables and fruits.

Read the story of "The Boy and Hushwing," from *The Kindred of the Wild*, by Charles G. D. Roberts.

PLANT STUDY

The Comparative Study of Orchard Trees

Two methods of dealing with this subject will be given.

Method 1: The best method of taking up the comparative study of trees is by making an excursion to

a nearby orchard, where the pupils can make direct observations upon the distinctive features of the trees.

LESSON: APPLE AND CHERRY TREES

We will suppose that the first kind of tree to be visited is an apple tree that has fruit on it.

Let us now learn how to recognize an apple tree when there are no apples on it.

Observe:

1. The length and diameter of the trunk.

2. The mode of branching. (The branches all come out from nearly the same place and grow outward and slightly upward.)

3. The bark on the trunk. If the tree is old, this is grayish-brown and tends to scale off in fine pieces.

4. The shape and texture of the leaves.

5. The twigs at the ends of the branches are somewhat stout and brittle and have a peculiar taste.

After these observations have been made, the class is conducted to an apple tree that is of a different age and size and has no fruit.

The pupils are asked to identify this tree, giving their reasons.

The class is next conducted to a cherry tree.

What kind of tree is this?

It is identified as a cherry tree. The observations of the pupils are so directed that they will perceive:

1. The trunk of the cherry tree is shorter and less stout than that of the apple tree.

2. The branches slant upward more sharply than those of the apple tree, and the terminal branches are slender.

3. The bark on the trunk is dark brown or reddish-brown and is less rough than that of the apple tree.

4. The leaves are longer, narrower, and more shiny than those of the apple tree.

5. The leaves and twigs have a "cherry" taste.

After these features have been observed, the class identifies other apple and cherry trees.

Upon a second excursion to the orchard, a review of the observations made in the previous lesson can be taken, and observations can be made upon the peach or the plum.

LESSON: PEACH TREE

The observations of the pupils should be so directed that they will perceive:

1. That the peach tree is smaller than the apple tree or the cherry tree.

2. That it has fewer branches and is more open.

3. That the bark is a greenish-brown and is smoother than that of the apple tree.

4. That the leaves are longer and more slender than those of the apple tree or the cherry tree.

Method 2: It will not be feasible for some classes to make an excursion to an orchard to study the trees. A lesson suitable for the class-room is outlined for such classes.

LESSON: COMPARISON OF THE APPLE AND THE PLUM TREES

Materials: Pictures of typical apple and plum trees.

Bark from each kind of tree. Leaves and twigs from each kind.

By means of the pictures compare the general forms of the trees, noting:

1. The branches of the apple tree spread more widely than those of the plum tree, the latter growing upward at a sharper slant.

From the specimens the following differences are discovered:

2. The bark of the plum tree is smoother than that of the apple tree. It is brownish-black, while that of the apple tree is gray.

3. The leaves of the plum are of a more uniform green on both sides than are the apple-tree leaves.

Such a lesson as this falls far short of a true nature study lesson, unless it stimulates the pupils to visit the orchards and see the trees, and in this way learn to distinguish the various kinds.

The following problems are given to direct the pupils' observations on orchard trees:

1. Find apple, plum, cherry, and peach trees in your home orchard or other local orchard.

2. Compare the apple and the cherry tree, noting in what respects they are different.

3. Compare several apple trees with one another, noting points of similarity and points of difference.

4. Are any of the points of difference due to the fact that the trees are of different ages? Are any of the differences due to the trees being of different varieties?

5. Make sketches of an apple, a plum, a peach, and a cherry tree.

Similar problems may be assigned on the other kinds of fruit trees.

CHAPTER IX

FORM III

WINTER

PLANT STUDY

Comparative Study of Common Evergreen Trees

It is advisable that the comparative study of evergreen trees be limited to the varieties of evergreens growing in the locality of the school.

The best method is the direct observational study of the trees. This can be made during an excursion under the direction of the teacher. (See study of orchard trees, Chapter VIII.)

Another method is to conduct the comparative study in the class room. When taught in this way it is necessary to use pictures of the trees and specimens of bark, cones, wood, and boughs with foliage. An outline for a lesson by the latter method is given below.

LESSON: COMPARISON OF PINE AND SPRUCE TREES

Materials: Pictures of typical pine and spruce trees

Boughs of pine and spruce, a specimen for each pupil in the class

Cones of pine and spruce. Wood samples of pine and spruce.

Method: The pictures are shown to the pupils, and, by comparing them, the pupils perceive that they are pictures of different kinds of trees.

The following differences are observed by the pupils:

The foliage of the pine is on branches that are some distance apart; so that the foliage is in separate masses (small masses in the case of the red pine, larger in the case of the white pine). The foliage of the spruce is in the form of a regular cone.

The names are then given. Next, the specimens of boughs are distributed, examined, and compared. It is found that:

1. The needles of the pine are longer than those of the spruce.

2. The needles of the pine are in groups (the number in a group varies with the species). Each group is set into a small, dark-brown base, common to the needles of the group. The needles of the spruce are not in groups, but are distributed singly along the twig.

The pupils next compare the cones.

The cones of the pines are not of the same shape as those of the spruce. The differences are discussed.

NOTE—Since the size and shape of the cones are different for the different kinds of pines or of spruce, no details have been inserted here. It is enough that the pupils learn to distinguish the cones that they have under observation.

The pupils next compare the woods.

The softness of the wood and the regularity of the grain distinguish the white pine from the coarser wood of the spruce.

Pine is used for lumber for building material. Spruce is used for lumber and railway ties, and also for making pulp from which paper is made.

To follow this class room study, the pupils should be assigned problems to direct their out-of-door observations.

Problems:

1. Identify from a distance pine and spruce trees. Give reasons.

2. By making observations close to the trees, test your previous conclusions.

3. How many kinds of pines do you find in your locality? Compare the bark, cones, needles.

4. How many kinds of spruce trees do you find in your locality?

5. Bring samples of cones and boughs of these trees to school. These will be used in review lessons.

Seat Work:

1. Make a sketch of a pine tree.

2. Make a sketch of a spruce tree.

3. Write a paragraph describing the uses of these trees for shade and for shelter.

Read:

All honour to the forest:
Each breeze a message brings,
"Be brave" from Oaks and Cedars,
"Look up" the Pine Tree sings.
"Oh, earth is fair," the Elm Tree calls,
"And Heaven is just above,"
"Do good," the Maples whisper,
All chorus—"God is love."

Alice Allen

LESSON: COMPARISON OF THE BALSAM AND THE SPRUCE

The balsam is one of the commonest of the Ontario evergreens. It is used extensively for shade and ornament. It closely resembles the spruce, but when found side by side they can readily be distinguished.

The methods of comparative study are the same as those outlined for the study of the pine and spruce.

The following points of resemblance and difference should be discovered by the pupils:

1. The general form of the balsam is much like that of the spruce.

2. The needles of the balsam are different from those of the spruce in the following details:

(1) Balsam needles are flat; that is, are two-sided. Spruce needles are not flat; they are round or triangular in section.

(2) Balsam needles are arranged along two sides of the twig. This makes the foliage spray flat or feather-shaped.

The spruce needles are arranged spirally along the twig. This makes the spray look like a small cylindrical brush.

3. The cones of the balsam are about two inches long. This is much shorter than the cones of the Norway spruce, an imported ornamental tree which is common in southern Ontario.

COMPARATIVE STUDY OF DECIDUOUS TREES

The winter study of deciduous trees, such as the elm, maple, oak, and horse-chestnut, is useful. Not only do the lessons provide means for training in observation, but they also serve to interest the pupils in the individuality of trees. The leaves are but the superficial expression of individuality, when these have fallen off, the essential characteristics of the trees are revealed.

COMPARISON OF MAPLE AND ELM TREES

The following points should be observed and discussed:

1. The trunk of the maple is continued nearly to the top of the tree, breaking up gradually into branches that slant upward.

The trunk of the elm, at about one-half to two-thirds of the whole height of the tree, breaks up into large branches which spread outwards like the ribs of an umbrella. This difference in branching causes the marked difference between the foliage masses of the two trees.

The maple presents a regular conical, or in some cases almost spherical, mass of foliage, while the elm presents a dome-shaped mass.

2. The main branches of the maple break up into a very large number of fine branches, which slant upward and outward.

The main branches of the elm break up into a number of fine branches, and these droop downward.

The numerous fine branches of the maple are capable of bearing a very great number of leaves. This accounts for the dense foliage of the maple. So dense is it that scarcely a beam of sunlight can pass through it.

The boughs of the elm bear a less dense foliage, but the graceful drooping sprays give to the elm a beauty which makes it a favourite ornamental tree.

ANIMAL STUDY

Outline Lesson on How Animals Prepare for Winter

Materials: Picture of a flock of geese or ducks migrating.

Picture of a beaver's house and pond.

Picture or diagram of a muskrat's hut.

A wasp's nest. Cocoons of insect larvæ.

A sample of the summer fur of an animal, such as the fox, or the mink, and a sample of winter fur.

Picture of a wood hare in brown summer dress, and one in white winter dress.

Open this lesson by a discussion of the way people prepare for winter. The following points will be brought out: Some people go to Florida or California. Those who stay here during the winter, (1) put food in stores such as cellars, pits, (2) prepare warmer houses—storm doors, windows, (3) put on warmer and more suitable clothes.

Among the animals, including birds and insects, there is a preparation for winter very similar to that which man makes. The pupils are asked to make any suggestions.

1. Some animals go south. These include nearly all birds, certain butterflies—one being the monarch or milkweed butterfly, and certain bats. What power is common to all these? Flight.

2. Some animals make stores of food. These include the beaver, chipmunk, squirrel, gopher, field mouse, bee. A brief discussion of the home and mode of storing in one or two of these cases.

3. Some animals prepare houses. These include the beaver, muskrat, squirrel, wasp, all insects that spend the winter in a cocoon, such as, cecropia and luna moth. Study pictures and examine specimens.

4. Some animals put on warmer clothes or more suitable clothes. These include the horse, cow, sheep; fur-bearing animals, such as the fox, mink, beaver, otter, etc.; animals that become white or nearly so in the winter, as, wood hare, weasel. The cotton-tail rabbit and the partridge are of a lighter colour in the winter than in the summer.

5. There are certain animals that make a preparation for winter that is different from any made by man; namely, by hibernating. The pupils will probably be

able to tell something about how the ground-hog, raccoon, and bear spend the winter. The teacher can give fuller information about hibernation.

A discussion should be held upon what the pupils have learned from their previous acquaintance with the animals, together with what has been learned by using the pictures or specimens.

To the Teacher: When hibernating animals go into their dens for the winter, they are very fat. The fat within their bodies serves as food during the long winter. They do not sleep, but pass into a condition in which the organs of the body are much more quiet than when the animal is sleeping. The heartbeat, for example, is much slower and more feeble, and the rate of respiration is much slower than the normal. If a hibernating animal is dug from its lair in midwinter, it cannot be aroused by blows as a sleeping animal can be. If it is placed in a warm place for a long time, it gradually returns to a normal state. In the spring, when the animal arouses from its hibernation, it is in very poor condition, for the food stored in its body has all been used to keep the animal alive during the long period of starvation. At this time of year bears are much more savage than at any other.

LESSON: THE RABBIT

Details, if studied in isolation, are uninteresting to Form III pupils. Detailed study should be placed upon the animal's habits, movements, and instincts, and each detail should be studied as an answer to questions such as: How is the animal able to perform these movements? How is it fitted for this habit of life? Etc.

Review the lesson on the rabbit that was taken with Form I. The detailed study contained in this lesson makes it necessary to have a living rabbit. The observations of the pupils are directed as follows:

Observations: Watch the rabbit moving. How does it move?

Which legs are the more useful for hopping? How are the hind legs fitted for making long hops?

In what way are the hind legs suited for defence?

Find out how the rabbit is fitted for burrowing.

Listen carefully and find out whether it makes much noise while moving. Of what advantage is it to the animal to move silently?

Examine the feet of the rabbit. What enables it to make very little noise.

How are these animals prepared for living during cold weather?

Test the ability of the rabbit to hear faint noises. Why is it necessary for it to be able to hear faint sounds?

How is it fitted for hearing faint sounds?

Examine the teeth and find out how they are fitted for gnawing.

To the Teacher: The long, strong, hind legs of the rabbit are bent in the form of levers and enable the animal to take long, quick hops.

When the rabbit is attacked, it frequently defends itself by vigorous kicks with its hind feet, which are armed with long, strong claws. Ernest Thompson-Seton's story of Molly Cottontail and Raggylug, in *Wild Animals I Have Known*, contains an interesting account of how Molly rescued Raggy from a snake by this method of fighting. The rabbit has many enemies; hence it has need of large, movable ears to aid its sense of hearing. The thick pads of hair on the soles of its feet enable it to move noiselessly. The thick, soft, inner hair keeps the animal warm, while the longer, stiffer, outer hair sheds the rain.

Impress upon the pupils the cruelty of rough handling of the rabbit and of neglecting to provide it with a place for exercise and with a clean, dry home.

OTHER PET ANIMALS

The following pet animals may be studied, using the same order and general method of treatment: pigeon, cat, canary, guinea pig, white mouse, squirrel, parrot. In many cases these animals can be brought to school by the pupils.

Encourage the keeping of pet animals by the children, for the best lessons grow out of the actual care of the pets.

The study of a pet bird may be conducted along lines similar to the outline given below for the study of the pigeon.

CORRELATIONS

Literature and reading. Ernest Thompson-Seton's *Raggylug.*

Art. Charcoal drawing representing the rabbit in various attitudes, as squatting, listening, hopping.

Modelling in clay or plasticine.

Paper cutting.

Language. The vocabulary of the pupils is enlarged by the introduction of new words whose meaning is made clear by means of the concrete illustration furnished by direct observation of the rabbit.

They use new words in sentences which they form in describing the rabbit; for example, hutch, gnaw, padded, cleft lip, timid.

The rabbit has padded feet so that it can walk without noise. The rabbit has a soft bed in its hutch.

Fish

The nature study lessons must be based upon observations of the living fish, preferably in May or June, September or October. The best place for this is on the bank of a clear stream from which it is possible to observe the fish in their natural environment. Here their life activities, their struggles, and silent tragedies are enacted before the eyes of the observer. Many observations may be made in this way which will create a life-long interest in these timid, active creatures. Since this method of study is practicable in but few cases, the study of the living fish in the aquarium is the best available substitute.

The teacher or the boys in the class can catch a few fish of three or four inches in length and carry them in a jar of water to the aquarium. Minnows, chub, perch, catfish, or other common forms will do. A goldfish is also suitable as a specimen.

THE FISH: TYPE PLAN FOR A LESSON

Materials: A goldfish in an aquarium.
A glass of water.

Teacher's Aim: To arouse the pupils' interest in fish as living creatures and to develop the pupils' powers of observation and expression.

Preparation: Discussion of where fish live and how they move, leading to the thought that they can live under water, which human beings cannot do, and can swim better. Why can they do these things?

Problem: We shall learn why fish can live under water and can swim better than human beings.

Presentation: Pupils are directed to observe the fish in the aquarium.

Compare the parts of a fish with those of a human being.

A human being has head, trunk or body, neck, limbs.

A fish has head, body, tail, and fins, but has no neck distinguishable as such.

Compare the general form of the fish with that of the human being, noting in what ways the form of the fish is more suited for swimming.

Points: A narrow boat-like form that cuts through the water easily.

A gradual tapering form, with no blunt head or shoulders protruding beyond a narrow neck to be obstructed by the water.

The flexibility of the body, especially the tail. (See black-board summary.)

What organs does the fish use for swimming?

How many fins are there? Describe their positions.

Give simple names, as shoulder or breast, body, tail and back fins. (See black-board summary.)

Look closely at the fish as it swims. What fin is the most useful for swimming?

The answer to this will be discovered when the fish is swimming fast. The pupils will then be able to see the strong twisting movement of the tail fin.

Of what use are the other fins?

Observation will reveal that they are used for swimming, also as balances and as brakes. The small pair of breast fins is kept in constant motion for a purpose that will be discovered later.

Examine the fins carefully and discover their structure—a thin membrane supported by flexible *rays*. The thin, broad surface can be compared to the blade of a paddle.

What other parts of the fish do you see moving? Describe the movements.

The mouth opens and closes at intervals.

The flaps just behind the head pulsate slightly.

What movements of the human body are suggested by the latter?

The pupils will see the resemblance to the movements of respiration.

If the fish is resting near the bottom of the aquarium, the currents of water expelled through the gill clefts

can be seen to move the finer sand below the fish. The pupils will learn from this that the water enters the mouth and passes out by the gill clefts.

By using a glass of water that has been kept in a warm place for half an hour, the small bubbles of air that come out of the water can be shown to the pupils. They may then be led to realize the mode of respiration of the fish.

When fishing or preparing fish for cooking, what have you found under the flaps that are on the sides of the head? The gills.

The air that is in the water that flows over the gills is used for breathing. To show that the gills are better than lungs for breathing in water, compare the lungs to a sack and the gills to a sieve. Through which can water pass the more readily? (See black-board summary.)

Look closely at the surface of the fish. With what is the surface covered?

Describe the arrangement of the scales.

For life under water why is a covering of scales better than a covering of hair or fur?

Points: The scales are smoother, hence have less friction against the water.

The scales are tough, therefore protect.

Warmth, such as is given by fur, is not necessary, as the fish is cold blooded.

What comes off the surface of the fish when it is handled?

This slime prevents the growth of bacteria on the skin of the fish—a very necessary protection, since bacteria grow very rapidly in water.

In what ways are the eyes of the fish protected from injury?

Have you seen it close its eyes? Search for ears projecting or opening from the head.

What disadvantage would it be for a fish to have ears projecting from the head?

Application:

1. Give a reason why the small pair of breast fins is kept in constant motion.

2. Describe all the features of the fish that fit it for (1) breathing under water, (2) swimming, (3) escaping from its enemies.

3. Why is it necessary to renew frequently the water in the bait pail containing a number of minnows.

Seat Work:

1. Make a drawing of the fish, showing all the organs mentioned above.

2. Correlate with geography by reading "Men Who Live by Hunting and Fishing," page 11, *Ontario Public School Geography.*

Black-board summary: Form—narrow, tapering.

Fins—1 pair shoulder, 1 pair breast, a pair body, single tail—swimming and rudder, others balancers, brakes, and movers, single back, single under.

Breathes air that is in water. Water enters mouth, passes out by gill cleft.

Scales, tough, arranged in rows, overlap.

SUGGESTIONS FOR FURTHER OBSERVATIONS ON THE FISH

By supplying various foods learn what kinds are preferred. Find, in the actions or habits of the living fish, evidences of a sense of smell, of sight, of hearing, and of taste.

Nearly all the following points of detailed study can be observed from the living fish: Shape; size; tongue;

teeth; gill slits leading from the mouth to the gills; nostrils, number and position; eyes, absence of eyelids; fins, size, build; the arrangement of the scales.

From these details the teacher can select a sufficient number, according to the length of the lesson and suitability to the class.

Problems: What features in the shape of the fish make possible an easy movement through the water?

Why does the fish require a large mouth?

How are the eyes protected? Compare the shape of the eyes with the shape of the eye of a land animal.

Show the suitability of the fins as organs of locomotion in water.

Why are scales a more suitable covering for the fish than hair or feathers?

REFERENCES

Silcox and Stevenson: *Modern Nature Study.*

Nash: *Fishes of Ontario* (from Department of Education, free).

Kellogg: *Elementary Zoology.*

The Habits and Adaptive Features of the Squirrel

The squirrel is one of the commonest of the wild animals of Ontario. It can be seen not only in all rural places, but even in the parks and shrubberies of our cities.

Since the squirrel can be easily observed, the experiences of the pupils, supplemented by a few careful observations made under the guidance of the teacher, will suffice as a basis of study. A squirrel kept for a

few days in a cage in the school-room will add greatly to the pupils' interest in the lessons, and will also provide a means for close observation of the details of such parts as the fur, teeth, and feet.

LESSON: THE SQUIRREL

In this lesson the movements and habits of the squirrel are observed, or recalled from past experience, and discussed. This will be a preparation of the study of the adaptive features.

Topics for observation and discussion:

1. Where does a squirrel spend most of his time?
2. How does a squirrel avoid danger when in a tree?

NOTE—It keeps on the safe side of the trunk or limb. It sometimes lies flat upon the upper surface of a limb, high above the ground. Its brown colour helps it to hide. It can leap from tree to tree.

3. When running on the ground how does it guard against danger?
4. How does a squirrel carry food to its store-house? Where does it store its food?

NOTE—The experiences of the pupils will probably include such facts as: The squirrel carries objects as big as a nut in its teeth, but small objects, such as grains, are carried in its cheeks. The red squirrel lays up large stores of nuts, grains, tree seeds, etc., near its nest. This is usually in a hollow tree or in a secluded part of a building. The nest is made of grass, shreds of soft bark, dry leaves, and moss.

5. How does a squirrel open a nut? Find the empty shells and examine the holes that the squirrels have gnawed in them.
6. At what seasons have you seen squirrels? How do they differ in this respect from bears?
7. What different feelings does the squirrel show by his voice?

8. Get the pupils' experiences upon the possibilities of taming a squirrel.

Relate the following true story:

THE SQUIRREL

Max was a boy of about the same age as one of you. He lived near a park in which there were many black, and gray, and red squirrels. Max became very good friends with one of these, and by and by it became so tame that it would take peanuts and cake from his hand. Max gave many a dainty treat to his little friend.

One day when Max was in a mood to tease, he pretended to be holding out a peanut for the squirrel to take, but his hand was quite empty. When the squirrel had come quite close he peered with all the might of his bright, black eyes into Max's hand but saw no peanut there. As though he could not trust his eyes he sniffed with his keen little nose. He was then fully convinced of the fraud. Quick as a flash his sharp little teeth bit into one of Max's fingers. Then with a saucy flip of his tail and a reproachful chatter he darted away.

This made it very clear to Max that even a squirrel expects to be given a square deal.

Problems to direct further observation.

1. How does a squirrel come down a tree?

2. How does a squirrel use its feet and legs so that it may secure the firmest possible grip when climbing?

3. How does a squirrel use its tail?

4. Find evidence that squirrels take the same path regularly from place to place.

These problems may be assigned to direct future observation work, but, even before the pupils have obtained answers to them, the lesson on adaptive features may be taken up.

NOTES FOR THE STUDY OF THE ADAPTIVE FEATURES OF THE SQUIRREL

1. The long, slender body is light and supple. The flatness of the body and the shortness of the legs lessen the danger of falling.

2. The sharp claws, the nimble "fingers," and the fact that the fifth finger can be used as a "thumb," help the animal to climb.

3. The short, upright ears, the bright eyes, the sensitive nose, and the animal's habit of sitting upright to give the senses the best possible chance to do their work, make for the alertness of the squirrel.

To the Teacher: There are two kinds of hairs, an outer coarse kind that acts as a thatch to keep the animal dry, and an inner downy kind to keep it warm.

In my cosy cap and coat, what care I for hail or sleet
With my tail around my throat, or wrapped about my feet.

If there is a squirrel under observation, the pupils will be able to observe the two pairs of large, front teeth. Each of these teeth is shaped like a carpenter's chisel, but they are curved. The curve aids in giving more force to the bite, and also helps to burst the chips of wood off. If there is no squirrel available for observation of the teeth, a picture or a diagram drawn by the teacher will be necessary.

4. The size of the hind legs fits the squirrel for leaping.

CORRELATION

Read "The Squirrel and His Jerky-tail Brothers," in *Wild Animals at Home*, by Ernest Thompson-Seton.

CHAPTER X

FORM III

SPRING

ANIMAL STUDY

Bird Observations

Interest in the recognition of birds as they return in the spring can be stimulated by continuing to work with a bird chart begun in Form II.

The Audubon Bird Charts, which contain pictures of many common birds, and a Bird Guide, such as Reed's *Bird Guide*, will be found helpful to those who are engaged in bird identification. The pupils should have access to these and should be given instructions in their use.

In addition to the birds studied in the list given above, the following also are birds that come close to our homes or are to be seen in the fields and by the roadside: Chipping sparrow, red-headed woodpecker, wren, phoebe, American redstart, catbird, purple martin, thrush, yellow warbler, oriole, cowbird.

LESSON UPON THE USE OF HELPS IN BIRD IDENTIFICATION

Begin by examining on the chart the picture of some bird that is well known to the pupils, such as the robin.

Ask the pupils to find, without looking at the names, a picture of a robin.

What features of the robin shown in the picture help to identify it?

The shape of the bird and the colours.

What colours are especially helpful to you in identifying the bird?

The grayish-black back and the red breast.

What characteristics of the bird are not shown in the picture?

The size, length in inches, habits, song.

Read the description in the Bird Guide and find these characteristics.

Now, when you see an unknown bird, what are the points that you must observe, in order that you may be able to identify the bird by using the Chart and the Bird Guide?

SUMMARY OF POINTS FOR IDENTIFICATION

Size—general shape—colour of head, back, and sides—conspicuous colours—other marks, as crest—shape of tail—size of bill—song—food—locality.

EXERCISE ON THE USE OF A BIRD GUIDE

The pupils are required to identify by means of the Chart and Bird Guide a bird for which the following description was obtained by observation:

Size—8 in. (midway between size of robin and sparrow)

Shape—resembles a large sparrow,

General colour—a rusty brown,

Conspicuous colours—many dark streaks on breast,

Song—a clear flute-like whistle heard in the evening,

Locality—in thick shrubbery and in the woods,

Habit—bird is shy and tries to keep out of sight,

Procedure—Look for a bird having the colours described. Look for a bird of the size given and having these colours. A comparison of the points given in the description of the bird observed with the descriptions in the book will lead to the identification.

The bird that was observed in this case was the wood thrush.

Each pupil is required to obtain a description of a bird previously unknown to him and test his ability to identify the bird.

BIRD GAMES

1. A large number of pictures of birds are hung around the room with a number attached to each. Each pupil writes the list of numbers in his exercise book, and places beside each number what he thinks is the name of the bird. The pupil who has the largest number of correct names is the winner.

2. The teacher places the picture of a bird before the class. A pupil stands behind the picture some distance, so that the class can see the picture. He asks questions, such as, What is the size of the bird? He names at the same time the pupil who is to answer. When the pupil on the floor guesses the name of the bird, the last pupil who answered must take his place.

Those who are inexperienced in making observations on birds usually fail to gather sufficient data, or they make inaccurate observations. The latter error is usually due to the fact that the observer does not succeed in getting close enough to the bird to observe the details of colour. A great deal of patience must be exercised in order to make a success of this branch of nature study, but no branch of the study gives greater pleasure when even a slight degree of success has been attained.

The observations must be made in such detail that, when a nature student has identified a bird through the expenditure of so much effort, he is not likely ever to forget the bird. Knowledge of its movements, song, and habits are also indelibly stamped upon his memory.

BIRD PROTECTION

1. Teach the following reproduction story as a preparation for a lesson on bird protection.

BOBBY'S BIRD LESSON

"Whatever can Farmer Will be doing!" exclaimed Bobby Brown as he raised his eyes from watching a meadow-lark glide to a place of safety in the centre of the farmer's hayfield, far beyond the range of his catapult. Bobby had spent an exciting half-hour stalking meadow-larks in Farmer Will's pasture field.

Bobby's exclamation was caused by seeing the farmer stop his mowing operations to gaze at a spot where Bobby could see nothing but hay, such as could be seen in every other spot. His curiosity was greatly increased when he saw the farmer alight from his mowing-machine, walk to a near-by fence, take up two pieces of old rail, and set them in the form of an arch. He was in the act of leaning a bundle of the newly mown hay carefully against this arch, when Bobby's curiosity quite overcame him, and he ran forward to inquire what it all meant.

Peeping under the arch, he saw the daintiest nest that a field sparrow ever did build, and in it four of the ugliest, nakedest, mouthiest little birdies that ever delighted the proud heart of a mother bird.

"But why," said Bobby, "why did you put this over the nest, Farmer Will?"

"I did not see the nest," said the farmer, "until I had cut away the hay that protected it, so I am trying to make up for the harm I did."

"But why should you care?" said Bobby. "You did not mean to harm them."

"No," said the farmer, "but I am sure I could not sleep for thinking of the poor little birds without any shelter from the cold winds at night or the hot sun by day, and no other music is so sweet to me as the song of a happy bird."

"Well! I never!" exclaimed Bobby five minutes afterwards, as he sat in the shade of a maple tree and broke his catapult into little pieces, "No, I never will!"

NOTES FOR A LESSON ON BIRD PROTECTION

As a preparation for a lesson the pupils should be led to realize that:

1. Birds are worthy of protection.
2. They are in need of protection.
3. How we can protect the birds.

1. Birds are worth protecting because—

(1) Their beauties of form and colour, their remarkable instincts, their sociability, and their sweet songs arouse our wonder and admiration.

(2) Nearly all kinds of birds are useful to the farmer, the gardener, and the fruit grower, by helping to hold in check the insects that destroy their crops, or by devouring great numbers of weed seeds.

Experience the world over has shown that, as bird life decreases, insects increase; also that birds are more efficient in keeping down insect pests than all other agencies, natural and artificial combined.

Even the owls and the hawks—birds that are commonly believed to be harmful because of their attacks upon poultry, are, upon the whole, very beneficial. Their food consists largely of mice, moles, squirrels, rats, grasshoppers, crickets, and beetles. Only a very few members of these families attack poultry or wild birds.

2. Birds need protection from—

(1) Certain other birds, as the shrike, sparrow hawk, English sparrow, bronzed grackle, and crow.

(2) Certain animals, as the cat, fox, squirrel. The latter destroy the eggs and young birds in a spirit of vindictiveness.

(3) Some boys and men. These in a spirit of sport, or from thoughtlessness, kill birds with stones, catapults, and guns.

3. How we can protect the birds—

When the enemies of bird life are known, the means to be taken for protecting the birds are nearly all evident.

(1) We must refrain from injuring birds.

(2) We must teach others to do likewise. (See Bird Protection Act—School Register.)

(3) We must make war upon squirrels, cats, and foxes.

(4) We must provide for the wants of birds—

(*a*) By hanging beef bones with shreds of meat on them in the trees in winter, for the chickadees and other winter birds.

(*b*) By setting out vessels of water where birds can come to drink in dry weather.

(*c*) By putting up bird houses in which blue-birds, wrens, woodpeckers, martins, robins, etc., will find suitable homes.

(*d*) By setting out shrubs and trees, when we have homes of our own, so that birds may find shelter and food.

PLANT STUDY

The Identification of Common Garden Flowers

The following flowers bloom in the spring and early summer and are suitable for lessons in identification: Crocus, daffodil, hyacinth, tulip, iris, peony, columbine, bleeding-heart.

The identification may be taught either by class room lessons or by excursions to the gardens where the flowers are growing.

Several flowers can be taken up in each lesson.

For the class room lesson secure specimens with leaves and stems, because these usually have distinctive properties that are helpful in identifying the plants.

In the observation work on the crocus, tulip, daffodil, and hyacinth, direct the attention of the pupils to the forms of the leaf and the flower.

In the testing part of the lesson use tulips and hyacinths of various colours.

Out-of-school problems:

1. Make a list of all the spring flowers you see in the gardens.

2. Name a garden that has a good display of tulips, one that has a good display of hyacinths.

CORRELATIONS

Spelling. Teach the spelling of the names of the flowers.

Art. Make reproductions of the flower in colour.

Gardening. How to grow these flowers from bulbs or roots.

THE STUDY OF A GARDEN PLANT

Type: pansy.

Materials: A complete plant.
A bunch of pansy flowers.
A collection of pansy and other leaves.

First take the general study of the plant, and obtain from the class the names of the parts—root, stem, leaf, flower.

Examine the root to discover how it is fitted for taking food from the soil and for holding the plant in place.

Observe the stoutness and the length of the main root, the numerous branches extending out in all directions, the crookedness of these branches which give the roots a grip on the soil.

Discover how it is fitted for holding the flower up in the sunshine and air. The stoutness, the branches, and the angular form of the stem.

Examine the leaves: The pupils should learn to identify the leaves by noting the general shape and the *wings* at the base of the leaf stem. Test by asking the pupils to pick pansy leaves out of a pile made up of several kinds of leaves.

Let us compare several pansy leaves, and we will find that no two are alike; indeed they vary considerably in shape.

The flowers: Some people say they can see the face of a lion in the flower, others a man, others a girl, others a dog. What can you see?

Find the little man in the centre of the flower. He has a green head and a little brown velvet collar. Touch the collar with the tip of your finger and find the yellow powder that the bee which visits the flower carries away on its head. In the next pansy that the bee visits the dust is rubbed on the little man's head, and this is the beginning of the life of the seeds.

Bite the tip off the spur of the flower and taste the nectar for which the bee visits the flower.

Note the lines of the flower that point toward the nectar sac.

Find the flower buds and observe that they are wrapped in a little green blanket which is called the *calyx*. Find the calyx of the open flower.

Find the seed pods in the centres of the withered flowers. The flowers grow chiefly that they may take care of the pods.

Of what use are the bright colours of the flowers?

The pansy blooms through the whole summer.

CORRELATIONS

Read:

The pansy wakes in early spring
To make our world more bright,
All summer long its happy face
Fills children with delight.

The root keeps working out of sight
That the flower may bloom so fair and bright,
Root, stem, and leaf, and flower, too,
Has each its little work to do.

Art: The pansy plant and flower—colour work.

ANIMAL STUDY

Life History of a Common Beetle

The life history of the Colorado beetle, commonly called potato bug, can be studied quite conveniently. At any time between the middle of May and the middle of August it is not difficult to find in the potato fields representatives of all the stages.

Direct the pupils to look for the eggs on the under surfaces of the leaves of the potato plants. The eggs are orange yellow and are in clusters which are quite conspicuous.

OBSERVATION EXERCISES

Describe the colour, shape, and size of the egg.

Describe the arrangement of the eggs in the cluster.

If an adult beetle is seen beside the cluster, she is probably laying the eggs. Watch the egg-laying process.

Mark this cluster and watch it until the eggs hatch. Record the date of each change. Describe the hatching and the young larvæ. How soon after they are hatched do the larvæ begin to feed and to spread over the leaf and over the plant?

How does the larva eat the leaves?

How many legs has the larva?

How many rows of black spots are on each side?

When the larvæ are quite well grown, transfer several of them to a potato plant growing in a flower-pot, and cover the plant with a large lamp chimney. Place some object on the upper end of the chimney to prevent the larvæ from climbing out.

When the larvæ are mature, they burrow into the soil and there pass into the pupa stage. When some of the larvæ have disappeared from the plant, carefully turn over the soil in the flower-pot and find a pupa. How does the shape of the pupa differ from that of the larva?

Make a drawing representing the pupa.

Return the pupa to the soil and await the emergence of the adult that is the striped potato beetle.

Find three points of difference between the adult beetle and the larva.

If it is more convenient to have indoor observations instead of field observations, prepare for these by planting potato sets in a large flower-pot. This should be planted at a date early enough to produce a potato plant to be used during the study of all the stages. Cover this plant with a large lamp chimney, place a wire gauze on top of the chimney, secure several adult potato beetles, and place them on the plant.

ADDITIONAL EXERCISES

Find larvæ of lady-bird beetles on asparagus plants, larvæ of meal beetles underneath flour or bran barrels, larvæ of June bugs in the garden soil. The latter larvæ are large, fat, white grubs. Feed these larvae in a

vivarium and observe the development into the adult beetle.

To the Teacher: The eggs hatch in about a week, the larvæ are mature and pass into the pupa stage about three weeks later. The pupa stage occupies from one to two weeks.

The potato beetle is a native of Arizona and Colorado. It began to move eastward in the late fifties and reached the Atlantic coast in 1874.

THE MOSQUITO

Time: May or June.

Questions and Observations: At what time of the year are mosquitoes most plentiful? In what localities are they most plentiful? Why are they most plentiful in these places? Are mosquitoes ever seen in the fall or winter? How do you account for the rapid increase in number early in the summer?

How do mosquitoes find their victims? Observe the humming noise and try to discover how it is made.

Watch a mosquito as it draws blood from your hand. Does the point of the beak pierce the skin?

Capture a number of mosquitoes and place them in a jar containing some rain water and a few straws or sticks standing upright out of the water. Cover the mouth of the jar with a glass plate or some fine gauze. Watch for the rafts of eggs on the surface of the water.

The eggs may also be found on the surface of ponds or open rain barrels, and transferred to water in a jar in the laboratory. If a jar of rain water is set on the outside of the school window in the afternoon in the mosquito season, the egg rafts may be found on the water next morning.

STUDY OF THE ADULT FORM

Note the shape, colour, sucking tube, wings, and legs. Compare with the house-fly.

Distinguish the male insect from the female; the former has feathery feelers and has mouth parts unsuited for biting.

How many kinds of mosquitoes have you seen? Direct attention to the kind that causes the spread of malaria. It is recognized by its habit of standing with its body pointing at right angles to the surface on which its feet are placed, or, in other words, it appears to be standing on its head.

DEVELOPMENT OF THE MOSQUITO

Describe the egg raft.

Observe the wigglers (hatched in about a day); the divisions of the body of the wigglers; position of the wigglers when at rest. Observe that the tail end is upward. Lead the pupils to perceive that this is the means of getting air.

Observe the rapid movement toward the bottom when disturbed; the means of causing this movement; the change into the large-headed pupa—a change which takes place about ten days after hatching; the almost motionless character of the pupa; the change from the pupa forms into the adult—a change which takes place at about the fourth day of pupa life.

Put some mosquito larvæ (wigglers) into the fish aquarium. Of what use are mosquitoes? The wigglers are the food upon which some young fishes live. Young bass and trout feed upon them.

Put some kerosene on the surface of a jar in which there are mosquito larvæ. Describe a method of destroying mosquitoes.

The teacher tells about the mosquito as the cause of the spread of malaria. From the fact that the eggs

hatch on stagnant water, deduce a benefit from the draining of land.

NOTE—The Mosquito Chart—G. M. Hendry and Co.—has a series of pictures that are helpful if used in connection with this observation work. Although the use of a Chart as illustrative material is not as good as the observational study of the real insect and larvæ, occasionally it is necessary to use it as a substitute. It may be the means of causing the pupils to become so interested that at some future time they will take up the observational study.

LESSON I: THE HOUSE-FLY

Problems to direct the study of the habits and movements of the house-fly.

1. Find out the places where house-flies feed. Consider the effect of this upon methods of keeping our food clean. Classify these as clean and filthy.

2. Watch the house-fly sucking up milk or the juice from a piece of pie or other food. Find out how it sucks?

3. On what parts of a room have you seen flies walking?

4. Find a place where there are no flies. Set some honey or syrup there and notice how soon the flies find it. With what sense do they find it?

5. Make tests to discover whether flies can see well.

6. Watch a fly performing its toilet operations. Does it cleanse its hands (front feet), its face, and its head, its hind feet and legs, its body? How does it cleanse each of these parts?

These problems should be discussed in the class after the pupils have made such observations and discoveries as they are able.

LESSON II: THE HOUSE-FLY

Materials: Several house-flies in a clear glass vessel. A hand lens.

To find out how the fly is fitted for doing the things it does.

Questions and instructions to guide in this study:

1. How many pairs of wings has the fly? Describe the colour and the texture of the wings.

2. How many pairs of legs has it? Examine the feet and find the hairs that carry the germs from one food to another. Find the hooks that are useful in climbing. You may not be able to see, even with a lens, the little sticky pads on the feet. By means of these the fly is able to crawl on smooth window-panes and to walk on the ceiling.

3. Examine the sucking tube. In appearance it is something like the trunk of an elephant. An elephant's trunk, however, is a peculiar kind of nose, while the fly's trunk is a peculiar kind of mouth. It is as though a boy's teeth and tongue and lips were all pulled out into a tube something like a garden hose and reaching out about four feet from his face.

4. Examine the head by means of the hand lens, and find the two large, bulging "eyes," one at each side of the head. With the aid of the lens these will be seen to be made up of thousands of little six-sided spaces. Each one of these spaces is an eye.

5. Find the pair of small antennæ. These are not used as feelers alone, but do the work of the nose.

OBSERVATIONAL STUDY: THE LIFE HISTORY OF THE HOUSE-FLY

Into a jar put a small quantity of horse manure, or wet tea leaves from the tea-pot after the tea has been poured off, or a piece of bread smeared with sweet jam. The first of these materials is the most certain to give

results, but the last is the least repulsive. Inclose a number of active flies in this jar. The flies will lay their eggs in the material in the jar.

As the eggs are white and small, about the size of pin points, it is difficult to find them.

Careful watch should be kept by the pupils, so that they may observe the stages of development.

If the jar is kept in a warm place, the eggs will hatch within a few hours into small white larvae. The larvae feed upon the medium in which they are hatched, and after about six days go into the pupa stage. The pupa case is a small yellowish-brown object somewhat resembling a grain of wheat. After about five days the case bursts open, and the adult fly comes out.

The pupils should keep a record of the dates of the several changes. They should also make drawings representing the stages.

The pupils have been put in a position to comprehend the most effective means of checking the fly pest; that is, by not permitting any moist, waste vegetable or animal matter, including manure, to be exposed to flies. They have learned, too, that all garbage and other waste material should be removed within a shorter time than that required for the development of the larvæ of the fly.

CHAPTER XI

FORM IV

AUTUMN

PLANT STUDY

Weeds

The method outlined for the identification of weeds by the pupils of Form III is suited also to the pupils of Form IV.

The collection of weed seeds, and the study of the properties of weeds that give them persistence and that make them harmful should be dealt with in Form IV.

OUTLINE OF LESSON: THE PERENNIAL SOW THISTLE

Preparation: The teacher exhibits a complete plant, that is, a plant having underground stem (root stock), roots, stem, leaves, and flowers, or more correctly, flower heads.

The plant is identified and distinguished from its less harmful cousins—the annual sow thistles.

Points fixing the identity:

1. The large yellow flower, larger than that of the others.
2. The tall, sturdy stem, more vigorous than that of the others.
3. The root stock, not found in the others.
4. The long, slightly prickly leaves.

The pupils' knowledge of the habits of the weed is tested.

Points discussed:

1. The kinds of fields and crops in which it grows.

2. The scarcity or prevalence, usually too prevalent.

Problem: We will learn what causes this weed to be so prevalent and so harmful.

Presentation: Lead the pupils to discover the means of spreading.

1. The root stock is examined by the pupils. They find the buds or young plants growing upon it at intervals along its entire length.

2. The habit, common to root stocks, of living over winter and producing a crop of young plants the next year, is discussed.

3. The seeds are found and described. Special attention is given to their great number and lightness, and to the silken plumes that act as parachutes for carrying them away.

The properties that give vigour to the plant are then discussed, such as:

1. The tall, strong stem

2. The large leaves, protected by prickly margins

3. The milky juice that closes a wound quickly. The acrid taste of the juice that makes the weed unpalatable to nearly all animals.

The weed is harmful in the following ways:

1. The circles of large leaves at the base of the weed, particularly in the case of young plants, cover the ground and smother out the seedlings of useful plants.

2. The stems and leaves take up space and crowd out plants of the growing crops.

3. The vigorous weeds take large quantities of food and water from the soil, thus robbing the useful plants.

4. The expense of harvesting and threshing is increased. More twine is needed and there are more sheaves to be handled.

5. The seed spreads rapidly.

Application: Recognize the weeds in fields of the locality, looking especially for the young plants.

Since the root stocks and the seeds are both agents in spreading the weed, we must not only prevent the weeds from maturing, but also kill the leaves, by cultivating the soil and growing smothering crops such as rape and buckwheat. If the leaves are not permitted to grow, the root stocks will starve.

STUDY OF A FEW TYPICAL FLOWERS AND THEIR ORGANS

Flowers suitable for a first lesson are buttercup, trillium, pepper-root, or any flower that has all the floral organs in simple, regular form.

Type: buttercup.

Materials: Each pupil should be provided with a buttercup flower. In addition, have on hand a plant bearing unopened buds and one bearing the withered remains of flowers.

The plant is identified by the pupils.

A general investigation of the parts of the flower follows:

The pupils look closely at the flower and find whether it is made up of only one kind, or of several kinds of parts.

How are the parts that are like one another arranged?

We will now study these groups of parts more carefully and learn their names and uses.

The *Calyx:* Begin with the outside group, that is the group attached farthest down on the flower stalk.

Describe this group. The pupils describe it, stating that it is a circle of small, yellowish-green leaves, five in number.

The teacher gives the name *calyx* to the group. The name is written on the black-board and pronounced by the pupils. Since the pupils have a heavy enough task in learning the names of the groups and the relations of the groups, etc., do not give the name *sepal* in the first lesson.

To teach the use of the calyx, exhibit the plant with the unopened buds. The pupils will find the calyx and will interpret its use, namely, to inclose the young flower and so protect it from wind and sleet and too bright sunshine.

The *Corolla:* Advancing from the outside, or lowest parts of the flower, describe the next group of organs.

This is described by the pupils as being made up of five (sometimes six or seven or even more) glistening, yellow leaves; each leaf is larger than the leaf of the calyx.

The teacher gives the name *corolla.*

Since the name *petal* is not new to the class, it may be given here as the name of each of the leaves of the corolla.

The uses of the corolla may be taught as follows:

1. The pupils will readily think of its use for beautifying the world.

2. What creatures visit flowers in large numbers? What do bees and wasps get from the flowers?

Honey is made from a sweet fluid called *nectar.* Nectar is in a little sac at the inner end of the petals.

The *Stamens:* Now look at the part of the flower that is inside the corolla.

How many kinds of organs are there here?

The pupils will discover two kinds of organs. The kind nearest the corolla is described as being small hairs or stalks, each having a little knob on the top of it.

The teacher gives the name *stamens.*

The *Pollen:* Ask each pupil to press the tip of a finger, previously wiped clean, upon the stamens of a flower that is fully mature, and then let the class examine the finger tips.

The fine yellow dust is observed and described, and the name *pollen* is given. The use of the stamen is to produce or grow pollen. Presently we shall learn the use of pollen.

The *Pistil:* The remaining organ or innermost organ of the flower is then examined and described. It is made up of small seed-like bodies, each having a little curl on its upper side.

This organ is called the *pistil.*

To teach the use of the pistil the pupils are asked to examine the remains of the withered flowers on the plant which bears them. They will discover that the only part of the flower that remains is the pistil. It has grown, and the curl has withered. The little parts look more like seeds than they did when the flower was young. The pistil has changed into the fruit.

The mystery of the pollen is partly revealed, when an insect which has just left a flower is captured as it enters another flower. Its face and hairy little legs will be found to be sprinkled with pollen. Part of this will be rubbed off upon the flower which it is entering.

What part of this flower is best fitted for catching the pollen? The pupils will see that the little curls of the pistil are fitted for this work.

The teacher should then explain that it is necessary for pollen to get upon this curl before the seeds and fruit of the plant can grow. Usually the pollen that is produced in a flower is not the pollen that causes the pistil to become the fruit, but the pollen that comes from another flower does this work. Insects such as bees, ants, wasps, moths, butterflies, etc., are the carriers of pollen from flower to flower.

Rapid drill for this lesson may be had by using a plasticine or paper or cardboard model of the buttercup flower. This is sufficiently large to be seen by all the pupils without effort, and the names, positions, and uses of the parts can be gone over quickly.

CORRELATION

Drawing: Make a drawing of the flower of the buttercup from each of the following views:

1. A side view, top of the flower slightly turned toward the observer, so that all the organs can be seen.

2. A surface view, looking directly down upon the flower.

3. A view of the inner surface of half of the flower. To prepare this cut the flower through the centre lengthwise, that is so that the cut produced would pass down the centre of the stem.

In each of the above cases name all the organs shown in each of the drawings.

LESSON PLAN: NASTURTIUM

Assignments for out-door observations: Watch the flowers of the nasturtium in the garden when the sun is shining and find answers to these questions:

1. What insects visit them?
2. On what part of the flower does the insect alight? Where does it go, and how does it get out again?
3. Where does the insect go when it leaves the flower?
4. In what kind of soil do the finest nasturtiums grow in the garden?

Materials for class study: A nasturtium plant in a flower-pot, a bouquet of flowers and leaves in a vase for reference if necessary, and a flower and a leaf for each pupil.

Preparation: What flower have we here? How many of you have it in your home gardens? What was done in the spring to get these plants to grow in the garden? Of what use are these flowers?

The nasturtium was brought to us from Peru and Chili, where it still grows wild.

Problem: Let us try to find out what the different parts of the nasturtium plant are like, and the use of each part to the plant.

Presentation:

Subject-matter	Method
The flowers, orange, yellow, red, and creamy white to nearly black, are signboards which attract insects in search of a sweet liquid, nectar, and a dust, pollen, which they feed to developing bees. The bees scatter some of the pollen from flower to flower. Without pollination these flowers could not produce seeds.	How many colours of flowers can we find in the class room? Which is the most beautiful colour? Of what use are these bright colours to the plant? For what do bees use nectar and pollen? What service do the bees render to the flowers in return? Of what use are flowers to bees? Of what use are bees to flowers?

The flowers stand out prominently among the leaves, on their long, straight stems.

Hence insects see them readily. The scent attracts insects from much greater distances than does the colour.

Examine the plant and see what makes the flowers stand out so prominently. Where do the stems arise which bear these flowers? What advantage is there in such long flower-stalks? If we could not see the flowers how could we know when they were near? What is the value of perfume to the plant?

The five sepals of the calyx are united at the base and together they form a tube which projects downward as a long spur. At the bottom of this spur is stored the nectar.

Notice the small coloured leaves, or sepals on the outside of the flower. How many sepals are there? Are they united or separate? To what peculiar structure do they give rise at the base? Bite off the lower end of the spur and taste it. What does it seem to contain? Of what use is this to the plant? What do bees do with it?

The corolla consists of five petals larger than the sepals. They grow upon the sepals. Like the sepals the two upper petals bear coloured guide lines which direct the butterfly, bee, or humming bird toward the nectar in the spur.

How many petals are there? etc. A petal is drawn on the black-board, to show the guide lines.

The butterfly or bee alights on the broad, outer end of the three lower petals. The fringe of hairs at the base of the expansion may serve as a barricade against smaller insects which might consume nectar without transferring pollen.

On what petals will the insect alight? How many petals are prepared to receive it? What is the advantage of the outer end of each being so broad? What is found at the base of the broad part? What must a bee or a butterfly do to reach the nectar? Could smaller insects get over it easily? Suggest a value for these hairs.

The stamens and pistil mature at different times, and, when ripe, each rises into the path which the bee follows in search of nectar.

Find the stamens and pistil. Push the blunt end of a pencil inward from the lower petals along the path which an insect would take in searching for nectar. Does it touch the stamens or the pistil? If it touches the former, see whether pollen sticks to the pencil, etc.

The outer end or stigma, of the pistil, being sticky, receives pollen from the insect.

When the petals fall the flower-stems coil up and draw the fruit down beneath the leaves where they are protected.

Remove a pistil that has risen into the path of the bee, and rub it in chalk dust. To what part does the dust adhere? What is the use of the sticky part?

Find the fruit of the plant. Note its size, shape, and colour. Why does it not stand out among the leaves as the flower did? Black-board sketches are made, to show the differences between stems of flowers and those of fruits.

Application:

Seat work:

1. In a note-book make drawings of the following parts of the nasturtium plant and name the parts drawn: (1) A flower, (2) an upper petal, (3) a lower petal, (4) a stamen, (5) a pistil.

2. Name those things which (1) attract insects to the flower, and (2) help insects to find the flower.

3. Tell what the insect does for the flower.

NOTE—Write answers to the above problems in the form of paragraphs and illustrate by drawings.

REVIEW LESSON: NASTURTIUM

Materials at hand: A bouquet of flowers and of leaves and a plant of the nasturtium are provided for reference in case of need.

Preparation: The plant and the bouquet are shown to the class.

Problem: While our preceding lesson is still fresh in memory, we shall review what we learned about the nasturtium.

Presentation: By rapid questioning the class reviews in brief answers the subject-matter of the previous lesson.

Have the pupils examine, where necessary, the concrete material provided. When a section of the subject-matter, such as that relating to the leaf, or the corolla, or the calyx, has been thus reviewed, have a pupil tell in good form all that he has learned about the topic. Any errors in understanding and in English are corrected during this exercise.

LESSON I: SEED DISPERSAL

Observation lesson on the seeds that fly.

Materials: A milkweed-pod; a ripe dandelion head.

Preparation: A short conversation about the effects of the crowding of plants, as carrots and turnips, in a garden plot, and hence the need for the scattering of seeds.

Problem: How does the plant do this scattering?

Presentation: Open a milkweed-pod in the presence of the pupils, so that they may see how the pod opens, how beautifully the seeds are arranged, and how closely the silk tufts are packed in together.

Allow a pupil to lift out a seed, blow it in the air, and observe how the silk opens out like an umbrella. Distribute seeds, one to each pupil. Ask them to find out why this little airship is able to carry the seed.

They will find that the seeds, though broad, are thin and light and the silky plumes very light.

Ask the pupils to release their milkweed seeds at recess, and see how far they can fly. This is an interesting experiment for a windy day.

The white balls of the dandelion are next examined, and the tiny seeds are found to be standing on tiptoe on a raised platform, each grasping a tiny parachute and waiting for a puff of wind to start it off. A pupil is per-

mitted to give the puff. Seeds are distributed, and the means of flight is compared with that of the milkweed. The shape of the seed is observed and also the tiny anchor points at the lower end, for clutching the ground when the seed alights.

Another lesson on seeds that fly can be based on the study of tree seeds, using those of the maple, elm, basswood, pine, and spruce.

CORRELATIONS

Art. Drawing of milkweed-pods and seeds, and drawing of the dandelion seedball and the seeds when floating in the air.

Reading and literature. Interpret the thought and read:

> Dainty milkweed babies, wrapped in cradles green,
> Rocked by Mother Nature, fed by hands unseen,
> Brown coats have the darlings, slips of milky white,
> And wings, but that's a secret, they're folded out of sight.

OUTLINE LESSON II: IMPORTANCE OF SEED DISPERSAL

Select a few weeds belonging to species which produce large numbers of seeds, such as wild mustard, white cockle, false-flax, etc. Distribute the seed pods among the pupils of the class and require them to estimate the number of seeds produced by each plant.

By references to observations made in the garden, help the pupils to recall the bad results, both to parent plants and to young seedlings, of improper scattering of seeds; namely:

1. The excessive crowding and shading, which causes the plants to become weak.

2. The impossibility for the large number of plants to get enough food and moisture, which results in the plants being small and worthless.

Discuss how the crowding of cultivated plants is prevented, and, in a general way, how nature provides for the scattering of seeds.

The great work of the plant is the production and dispersal of its seeds.

Ask the pupils to be on the alert to find examples of plants in which provision is made for the dispersal of the seeds, and to bring these plants to the class for the next lesson.

LESSON III: METHODS OF SEED DISPERSAL

Make use of the specimens gathered by the pupils and by the teacher for observing and classifying as follows:

1. Seeds that steal rides. Examples—burdock, blue burr, pitch-fork weed, barley, stick-tight, hound's tongue.

2. Seeds that are carried in edible fruits which have attractive colours, tastes, etc. Examples—apple, grape, cherry, rowan, hawthorn.

3. Seeds that are carried by the wind. Examples—dandelion, thistle, milkweed, maple, pine, elm.

4. Seeds that are scattered by being shot from bursting pods. Examples—violet, jewel weed (touch-me-not), sweet-pea, witch hazel.

5. Seeds that are scattered by plants which are rolled along by the wind. Examples—Russian thistle, tumble-mustard, tumble-grass.

6. Seeds that float. Very many seeds float, although not specially fitted for floating, and some, such as those of the water-lily and the cocoa-nut, are especially adapted for dispersal by water.

To the Teacher: Require the pupils to observe the special structure that facilitates the dispersal of the seeds. As an illustration, ask them to find the seeds of the burdock and to describe what the burr is really like. They find that the burr is a little basket filled

with seeds. The basket has many little hooks, which catch on the hair of the animals, and, since these hooks turn inwards, they serve to hold the basket in such a position that all the seeds are not likely to drop out at one time. The pupils should also observe that these baskets are quite firmly attached to the parent plant until the seeds are ripe; after that the baskets break off the plant at the slightest pull.

LESSON IV: MAN AS A DISPERSER OF SEEDS

Man as an agent in the scattering of seeds should be made a topic for discussion.

Obtain, through the pupils, samples of seed grain, clover seed, timothy seed, turnip seed, etc. Ask the pupils to examine these and count the number of weed seeds found in each.

The results will reveal a very common way in which the seeds of noxious weeds are introduced.

Describe the introduction from Europe to the wheat-fields of the Prairie Provinces of such weeds as Russian thistle, false-flax, French-weed. The seeds of these weeds were carried in seed-grain, fodder for animals, and also in the hay and straw used by the immigrants as packing for their household goods.

Careful farmers will not allow threshing-machines, seed drills, fanning-mills, etc., to come from farms infested with noxious weeds to do work upon their farms, nor will they buy manure, straw, or hay that was produced on such farms.

ANIMAL STUDY

The Grasshopper

Soon after the opening of the autumn term ask the pupils to bring a number of grasshoppers to put into the insect cage. A thick sod cut from sandy soil should be

set in the bottom of this box and should be wetted occasionally.

The grasshoppers in the cage will serve for class room observations; but it is also necessary for the pupils to make field observations.

Problem studies for field observations:

1. In how many ways can grasshoppers move from one place to another?

2. What other means do they possess for escaping from their enemies?

3. Name all the kinds of plants on which grasshoppers feed?

They also eat animal food, such as woollen cloth, leather, etc.

4. Which do they prefer—sunshine or shade, warmth or cold?

5. What part of the leaf does a grasshopper bite when it is feeding? How does it hold the leaf so that it can bite it?

6. Look closely at a grasshopper when it is at rest and observe the movements that indicate breathing. In what part of the body do these take place?

To the Teacher: The grasshopper can move by walking, leaping, and flying. It can escape from its enemies by these movements, and sometimes it makes use of one and sometimes of another. When you try to catch a grasshopper, it sometimes evades you by slipping quietly into the grass by walking. Though grasshoppers live almost wholly upon vegetable food, they will sometimes eat woollen clothing and the leather straps of harvesting machinery. Grasshoppers revel in the sunshine. They hop and fly about and appear to enjoy its warmth; but when it is cold or cloudy, they take shelter on the fences and among the weeds.

The grasshopper finds safety not only in its powers of movement, but also in its colour. It so closely resembles the vegetation on which it feeds that only very sharp eyes can detect it. When it is seized, it pours from its mouth a black fluid which is repulsive, though it does not appear to possess any other repellent qualities. The hard shell that covers the grasshopper like a complete suit of

armour affords a very efficient protection. A blow that would kill a squirrel would scarcely stun a grasshopper.

It is not difficult for the pupils to make the field observations required in the above exercise. The problems may not all be correctly solved, but when the pupils discuss the answers with the teacher, they will recall having seen nearly all the things discussed.

STUDY OF ADAPTIVE FEATURES OF THE GRASSHOPPER

The insects kept in the cage will serve for the lesson on this topic.

1. How many parts, including legs and wings, are protected by a hard covering?

2. Where is this covering the hardest of all? Why is it a wise arrangement that it is so hard there?

3. How many pairs of wings has the grasshopper? Which is the protecting pair? Why is the other pair folded up so snugly?

4. Find the eyes, feelers, "teeth," and ears.

NOTE—The ears are a pair of oval-shaped membranes, one underneath each wing.

5. Find a row of small oval-shaped pores along each side of the body. There is one such pore on each side of each body division (segment). These are the openings of the breathing tubes of the insect.

6. The rear end of certain grasshoppers terminates in a hard, pointed organ. This, when opened up, is found to be formed of four pointed objects. These, when pressed together, inclose a tube which runs down the centre of the hard organ. By means of this organ the grasshopper drills a hole in the ground for a nest; and then passes the eggs through the tube into the nest. The grasshoppers that have this "egg-placer" are females.

Look for places in sandy or gravelly fields where grasshoppers are seen upon the ground. They will probably

be at work making the nests and placing the eggs. Dig into the soil and secure the nests for the insect cage, or catch a number of female grasshoppers and put them into the cage that has the sod in it (see Chapter XVI). There the process of egg-placing can be observed.

LIFE HISTORY OF THE GRASSHOPPER

If the cage with the sod containing the grasshoppers' eggs is kept moderately moist and in a warm, sunny place, the eggs will hatch in late winter or early spring, and the development stages of the grasshopper can be observed.

If this is not a success, the pupils can be given the following problem to solve by out-of-door observation:

Upon a bright, sunny day in early spring (about the beginning of April), get down on your hands and knees in a sunny spot in a pasture field or meadow where grasshoppers were plentiful last summer, and you will be very likely to see little creatures, each about one-fourth of an inch or less in length, that hop about. They are young grasshoppers. You will readily perceive this, for they look very much like their mothers, except that they are of a uniform dark colour and have no wings. They are sometimes called larvæ, but more usually *nymphs*.

If you look for these about a week later, you will find that they have grown larger. Like the rapidly growing boy who outgrows his clothes, the nymph outgrows its skin. The old skin bursts open, and the nymph slips out dressed in a complete new suit. This skin is outgrown in its turn, and another new suit is forthcoming. These changes are called *moults*. After the third moult the wings make their appearance. They look at first like little knobs, but lengthen rapidly and take on the shape

of wings. With the fifth moult the grasshopper's development is complete. There is, therefore, no period of rest in the life history of the grasshopper corresponding to the resting or pupa stage of the house-fly.

LIFE HISTORY OF A MOTH OR BUTTERFLY

This study is begun in the autumn, when the egg and larval stages of the insects are to be observed. Though the egg of certain forms can be found without difficulty, as in the case of the tussock moth or the cabbage butterfly, we must usually begin by finding the larva. If the larva is not full grown when found, it must be kept in a cage and supplied with the food upon which it was feeding when captured.

Look for larvæ on the leaves of carrots, the branches of shade trees, on lilac bushes, and on tomato vines. The black "worm" with tiger-like stripes, that strips the leaves off the carrot is the larva of a beautiful butterfly called the Eastern Swallowtail. The very large pale green larva of the cecropia moth feeds upon the foliage of forest and orchard trees. We sometimes happen upon this larva when it is full grown and is wandering about in search of a place to spend the winter. The larva of the tomato sphinx moth is the formidable worm-like creature that eats the leaves of the tomato vines. The larva found on the lilac bushes develops into the graceful promothea moth. If the larvæ cannot be found, the searchers will be almost sure to be rewarded by finding the cocoons.

In the studies of the life histories of moths and butterflies, one of the most interesting operations that can be witnessed is the weaving of the cocoon. The class is fortunate when it secures a large larva such as the cecropia, and has an opportunity to watch it weave

its cocoon. Here and there, back and forth, it sways its head. With each movement a thread is strung and is fastened at both ends. Despite the apparently clumsy and aimless movements of the weaver, in a surprisingly short time it is completely inclosed in a winter sleeping bag more perfect than any that ever sheltered an Arctic explorer. The winter home of the cecropia is wind-proof, rain-proof, and almost frost-proof.

Cocoons may be stored for winter study in a box or cage. Soil should be placed in the bottom of the cage, so that the burrowing larvæ, such as the sphinx, may be able to cover themselves. The cage should be kept in the coolest part of the school building, in order to be as near to the natural out-of-door conditions as possible. If the chrysalids are kept too warm, their development will be too much hastened, and the insect, when it emerges, will very likely be deformed. Thoroughly drenching the cocoons with water about once a month also assists in a natural development. Very early in the spring bring the cage into a conspicuous place in the school-room and instruct the pupils to watch for any movement.

OBSERVATIONS ON LARVÆ

Larva of sphinx moth, as a type.

1. Observe the motionless, sphinx-like attitude.
2. What is the colour? How does the colour help this larva to avoid being seen?
3. At which end is the horn?
4. Describe any peculiar or noticeable marks in the larva.
5. Has it more or fewer legs than a butterfly?

NOTE—There is absolutely no foundation for the belief that the horn can inflict a poisonous wound.

OBSERVATIONS ON COCOONS, CECROPIA

1. Find a thread of silk of which the cocoon is formed. Test its strength.

2. Note the leathery nature of the outer layer of the cocoon due to a paste spread over the silk.

3. How is the cocoon fastened to the limb of the tree or other support?

4. Find the hole by which the insect has emerged.

5. Cut the cocoon open from end to end and notice the number of layers in the walls of the cocoon.

6. In the cavity you will find the blanket in which the insect spent its sleeping or pupal stage. Describe the blanket.

NOTE—This cocoon has two walls, a strong outer wall and an inner wall which is softer and thinner. Between these is a space which contains air, there being only enough loose silk in the space to keep the walls separated. Compare this to the structure of the wall of a house which, for warmth, is built with two layers inclosing an air space.

The tomato worm does not make a cocoon of silk. It burrows into the ground in September, and a case, something like the blanket found in the cocoon of the cecropia, grows over it. A peculiar feature of this case is the long, handle-like part in which the tongue of the moth grows.

The pupa case of the Eastern Swallowtail is the same kind of covering as that of the tomato worm.

THE ADULT MOTH OR BUTTERFLY

1. Describe the size of the insect.

2. How many wings and how many legs has it?

3. Describe the body of the moth.

4. Describe the colours on the wings.

5. Find the pair of feelers at the front of the head. Describe their appearance.

6. Describe the movements of the insect.

CORRELATIONS

Make drawings when studying each stage of the development.

Write a history of the insect that was studied.

Make plasticine models of the larva and the cocoon or pupa case.

THE MUSKRAT

Introduce the study of the muskrat by a discussion with the pupils upon its habits, such as, muskrats live in the marshy borders of streams, ponds, and lakes; they swim and dive in the water.

The fund of knowledge possessed by the pupils will soon become exhausted, and the teacher will have an opportunity to present problems to guide the field observations.

Problems:

1. Describe the course a muskrat takes in swimming.
2. How much noise does it make when swimming?
3. What organs are used to propel it through the water?
4. Why does it sometimes stop swimming and remain motionless on the surface of the water?
5. Describe what the muskrat does if it is suddenly alarmed when it is swimming, and try to explain the value of each action for securing its own safety or that of its friends.
6. If you wish to find where a muskrat's home is, watch the animal as it approaches the shore. Where is the doorway of its home?
7. When the water gets low in summer so that it retreats from the bank, how does the muskrat secure a water way to the door of its home?

8. Look for the dome-shaped winter house of the muskrat. Describe this house under the following heads:

(1) Whether is it built in shallow or in deep water?

(2) How high does the top of the house rise above the surface of the water? How does the depth of the water immediately around the house compare with the general depth of the surrounding water? Why is there this difference in depth?

(3) Of what material is the house constructed? If you have ever had the opportunity of seeing the muskrats gathering this material, describe the operation.

NOTE—If you find a house in early autumn, no harm will be caused by opening it from the top, to find out where the living-room is and to learn the means of making it dry and warm. Find, also, the ventilating shaft which leads like a chimney to the top. It would be cruel to open the house in late autumn or winter, because the muskrat might not have time to repair the damage before the frost would obstruct the work.

9. Watch a muskrat feeding. How is its winter home planned to make possible the securing of food throughout the winter?

10. How does a muskrat open a clam-shell? To answer this examine the heaps of shells that are found in the shallow water near the margins of the ponds in which muskrats live. Why are these shells left in heaps or beds?

To the Teacher: The muskrat is one of the most interesting of the fur-bearing animals. Its instincts for self-preservation and for the continuance of its species are marvellous, and it is fitted in a remarkable degree for its semi-aquatic life.

By using its long, flat tail for a propeller, and by making strong strokes with its webbed hind feet, it swims swiftly and with great ease. When alarmed it disappears instantly below the surface of the water with a loud splash that warns its companions, even though they are a long distance off, that they must be on the alert. It can remain under water for a long time and can swim almost as fast under the water as on the surface.

Its summer home, and often its winter home as well, is in a burrow, the entrance to which is in the vertical or sloping bank

of the pond. This entrance is usually under water and is frequently among the roots of trees or shrubs. There may also be one or more concealed entrances leading from the land. The animal makes canals when necessary at times of low water, as in the dry summer season, to preserve a water way to its door. It makes these canals deep enough to ensure that the water will not freeze down to the bottom in cold weather, and thus make it impossible for it to reach its food.

Its food consists of the juicy roots and stems of aquatic plants. It also eats small water animals, clams being a favourite food. Its capacity for staying under water enables it to obtain its food from the bottom of the stream or pond, even when the surface is completely covered with ice.

When the animals build a winter house of reeds and rushes, they locate it in the shallow water, some distance out from the shore. This makes the rat secure against the attacks of land enemies, such as foxes, wolves, and wild cats. For, even though these can reach the house after the ice has formed, by that time the walls will be frozen as hard as stone. Around the base of the house and just outside it the muskrats sink a trench deep enough to ensure that the water in it will not freeze to the bottom in the coldest weather. The entrance to the house opens into this trench, and a second trench leads from the first out to deep water. These trenches ensure for the muskrat a water route throughout the winter.

When you have an opportunity to examine a muskrat, note the following features, and their adaptive qualities: The chisel-like front teeth, the very small ears, the short neck, the webbed hind feet, the flat tail covered with scales, the two kinds of hair—a longer, coarser kind, that can be pressed down upon the soft, downy fur to help to make the latter waterproof.

THE BEAVER

As it is very unlikely that any public school pupil will ever see a beaver engaged in its ordinary activities, unless it is at the Canadian National Exhibition, a picture-story lesson on this animal is the only feasible means of study.

Preparation: Begin the lesson with short descriptions of a beaver-pond and lodge and of how these are built.

Problem: Let us now find how nature has fitted the beaver to live as it does.

Presentation: Using a Mumford picture which illus-

trates the beaver and its natural surroundings, direct the observations and thought of the pupils as follows:

What structural features of the beaver are interesting or peculiar?

The pupils should find the following:

The beaver is a strong-looking animal. The body is plump and large and tapers gradually from the nose to the rump. The ears are small. There are two pairs of very long, strong, chisel-shaped teeth at the front of the mouth. The feet are large and webbed. The tail is broad and flat and is covered with scales.

As each structural feature is described, its fitness for the animal's mode of life is discussed.

Why are teeth of this shape useful to the beaver? Study the picture to find illustrations of its work.

Of what use are the webbed feet? Compare with the feet of a duck.

What advantage is it to an aquatic animal to have a smooth tapering form of body? Compare with the head and the body of a fish.

What is the use of the broad, flat tail? Compare to the propeller and rudder of a ship.

Why are small ears more suited to an aquatic life than large ears?

CORRELATION

Read "The Industrious Beaver" from *Wild Animals at Home*, by Ernest Thompson-Seton, or "The House in the Water" in Chas. G. D. Roberts' book *The House in the Water*.

CHAPTER XII

FORM IV

WINTER

PLANT STUDY

A TRUE project requires the solution of various problems in the accomplishment of some piece of concrete work. For example, the making of a sleigh by a boy is a project, and it involves many problems.

A project, so far as it can be carried on in school, on the eradication of weeds is here presented as a type.

THE ERADICATION OF WEEDS

Preparation: A general study of the common noxious weeds should precede the work on the project. This study should make the pupils familiar with the name and a few of the most noticeable features and habits of each weed.

We will assume that the following weeds are prevalent in the locality, and that the pupils have learned their characteristics: Dandelion, burdock, curled dock, common wild mustard, wild oat, ragweed, lambs quarters, ox-eye daisy, purslane, perennial sow thistle, couch grass, Canada thistle.

The pupils must be put into such an attitude toward the problems to be dealt with in the carrying out of the project that they will be desirous of solving them. The important thing, therefore, is to get the right start.

Here is where the skill and personality of the teacher are of supreme value. It is not so much what he dis-

cusses with the class, as the way in which he discusses it, that has the effect of inspiring the pupils to undertake the work upon the project with enthusiasm. This phase of the preparation for the project on weed eradication may consist of a discussion of such a question as—Is it true that certain weeds, such as wild mustard (assuming that this is a weed of the locality), can become so plentiful in a field that the weed cannot be eradicated?

Pupils and teachers discuss this for a few minutes, but the problem is left unsolved, in order that the pupils may talk it over with their fathers and older brothers who have had greater experience with weeds.

Some days later the question is again considered for a few minutes. Very likely the class is farther than ever from a unanimous decision. The teacher then proposes that the pupils combine their forces and make an attack on this question by treating it as a project in which every one will take some part.

In carrying out the project every one is to get all the information possible upon the subject from every possible source. The teacher then presents the project—"To get all possible information on the eradication of weeds," and assigns the problems to the class units.

Another mode of preparing the pupils for this project is for the teacher to make a startling statement, such as, "It is said that in every year the weeds cost Canada more than the total annual cost of conducting all the schools and churches in the Dominion." Question—Do you believe this?

Discuss all costs, as, labour spent in removing weeds from the crops; loss to the crops caused by the starving, smothering, and crowding out of useful plants by weeds; cost of binder twine and labour for harvesting and

threshing sheaves that are from ten per cent to ninety per cent weeds; expense of cleaning grain to make it fit for market; decrease in value of clover seed and seed grain that contain weed seeds.

Problem: Should not every one in this school section combine to put an end to this useless expense? Then let us start the campaign by getting every one interested in this project. The teacher in this way presents the project and its problems.

Method: As this is a project that calls for extensive observation and inquiry, it is advisable to divide it into parts and to allot a division to each pupil or to each group of pupils. For example, four divisions can be made of the weeds named in the foregoing list, as follows:

Division 1, dandelion, burdock, curled dock;
Division 2, wild mustard, wild oat, ragweed;
Division 3, lamb's quarters, ox-eye daisy, purslane;
Division 4, perennial sow thistle, couch grass, Canada thistle.

In case there are only four pupils in the class, each pupil will be made responsible for one of these divisions. If there are twelve pupils in the class, they will be divided into groups of three, and each group will be made responsible for one division. If there are five pupils in the class, it will obviously be advisable to make five divisions of the weed list; or for a class of six, three divisions with three groups of two students in each would appear to be a good arrangement. Each group will elect a leader who will assist in directing its work.

While the above list is composed of the most troublesome of farm weeds, it would not be suitable for every locality. Some of those in the list will not be prevalent

in certain localities; these would be omitted, and other weeds of the locality substituted. The list may also be increased or diminished to suit the existing conditions.

To direct the investigations of the pupils the teacher should submit to them a set of problems upon the project.

Problem No. 1: What are the peculiar features of each weed in the division of the list for which you are responsible, that make this weed hard to eradicate?

To answer this examine the weed, study descriptions of it in weed bulletins, such as, *Weeds of Ontario*, preserve specimens that will illustrate these features, make drawings illustrating the noteworthy features of the weeds, and prepare a written description.

Problem No. 2: Find out how difficult it is to eradicate each weed of the division of the list for which you are responsible.

To do this consult your parents and other progressive farmers and gardeners as to what efforts they have made, how long they have tried their methods, and what successes or failures they have had. By consulting people who have had experience in combating weeds, and by the study of books on weeds, find out how long the seeds or root stocks, as the case may be, have been known to be dormant in the ground. Be especially careful to make inquiries about ox-eye daisy, wild oat, common wild mustard, and perennial sow thistle.

Problem No. 3: What are the most recent methods of eradication of the weeds of the division of the list for which you are responsible?

To secure answers to this problem the pupils should write to such sources of information as the Department

of Agriculture, Ottawa, and the Agricultural College, Guelph, and should consult farmers.

The pupils should be taught to ask clear, definite questions upon the points upon which they are seeking information. The following are given as types of inquiries:

1. How can perennial sow thistle be most quickly and thoroughly eradicated from a field that is completely overrun by it?

2. What good is summer fallowing as a means of eradicating weeds from a farm that has become badly infested with common weeds, such as pigweed, ragweed, tumble-mustard, and rib-grass?

3. Of what use is summer fallowing as a means of weed prevention?

4. Would not a proper rotation of grass crops, hoe crops, and grain crops, produce as good results in a less costly way?

Although time must be allowed to the pupils for securing answers to the problems, they should be expected to have oral answers or answers in note form for the first problem at the end of a week, and for the second problem at the end of the second week, and so on.

While the work is being carried on, there should be displayed on the walls of the school-room pictures of the weeds, prepared specimens illustrating the important features of roots and seeds, and letters received by the pupils in answer to their inquiries.

CORRELATIONS

The writing of letters in connection with the project should be made the occasion for composition lessons on correspondence.

Written reports by the pupils should be made the means of impressing the importance of good penmanship and correct spelling.

The presenting of reports upon the results should be used to give training in oral composition and the writing of essays.

This trains the pupils to utilize the results of their researches.

When the class is divided into groups of two or more, the leader of each group is required to go over the answers obtained and delete all irrelevant answers and all duplicate matter. In case of contradictory or unsatisfactory answers the group should work over again the necessary parts, until uniformity of results is obtained.

The results obtained by the several groups must now be organized, and the information gained by each group passed on to the others. This is done in a class lesson or lessons, or during the literary period on Friday afternoon. The pupils read their reports, read passages bearing upon the subject from books and bulletins, exhibit pictures and other materials, submit the opinions of authorities, and an open discussion and an exchange of ideas take place. The summary of the results of the investigations is written on the black-board by the teacher.

Application: The knowledge gained by the working out of the project should be applied by the pupils in their school garden or home garden work, and later in their farm and garden operations. The teacher should cause his pupils to realize that they are expected to make such application of their knowledge.

Under our present system of school organization, it may not be feasible to carry out with a Third or a Fourth

Form class more than one such project a year in nature study. The educational benefits from such projects are unquestionably great, and every teacher who wishes to be progressive should undertake to teach some part of the work by this method.

ANIMAL STUDY

Combating Injurious Insects

It is necessary that the pupils should know something about the chief types of insects and their habits, in order that they may understand why certain means must be used to combat certain insects and quite different means to combat other insects. It is, therefore, more important to teach to the pupils of this grade the general facts relative to types of injurious insects and the methods of combating them, than to teach the details of the preparation and the mode of application of specific poisons. Such lessons taught at the close of the winter will prepare the pupils to understand something of the spraying operations that begin in the early spring.

LESSON I: INJURIOUS INSECTS AND HOW TO COMBAT THEM —BITING INSECTS

Recall the cabbage plants.

What insect larvæ attack these plants?

How can you tell by examining the leaves that the cabbage worm is attacking them?

This shows us that the cabbage worm bites out pieces of the edges of leaves and also eats holes in them.

Recall the habits of the potato beetle.

Like the cabbage worm, the potato beetle also eats holes in the leaves of its food plants.

Where must poison be sprinkled so that it may be eaten along with the food of these insects?

The cabbage worm and the potato beetle are called *biting* insects.

Such insects can be killed by sprinkling poisons, such as Paris green and arsenate of lead, over the surfaces of the plants upon which they feed.

How may this method be dangerous to men and animals?

A poison such as hellebore, which is harmless to useful animals, is frequently used on cabbages.

OTHER BITING INSECTS

The tent caterpillar on fruit trees, the army worm on grain crops, the cutworm in gardens and fields, the grasshopper in pasture, hay, and grain-fields, the currant worm, the gooseberry worm.

Of the above, certain ones cannot be curbed by applying the ordinary poisons to the food plant without exposing farm animals and human beings to the danger of poisoning. For these, special methods of poisoning are necessary.

LESSON II: SUCKING INSECTS

At this season of the year only a few insects are obtainable for illustrating this type. Any neglected orchard will supply examples of scale insects, such as the oyster-shell scale or the San José scale. House plants are sometimes infested with aphids, and these may be used.

Examine the twigs where the scales are living or the leaves that are infested with aphids. What condition of the leaf shows that these insects are different from the cabbage worm?

These use their tube-shaped mouth parts to puncture the skin of the plant, just as a mosquito uses its beak to puncture the skin of your hand. They suck the juices from beneath the skin of the plant, just as the mosquito sucks the blood from beneath the skin. Try to see the sucking mouth parts of the aphids. These insects belong to the type known as *sucking* insects.

Other sucking insects are leaf-hoppers and rose bugs.

What effect would poisons sprinkled on the surface of the food plants have on sucking insects? Why would they not be effective?

The remedy for these is to spray with some material that will kill the insect when it comes in contact with the surface of their bodies. Such a poison is called a *contact* poison.

Some more usual contact poisons are: Tobacco extract, including nicotine sulphate, kerosene, whale-oil soap, pyrethrum powder, hellebore, which kill by obstructing or poisoning the breathing pores, and lime sulphur, which probably kills by burning the surface of the insect.

INSECTS WITH UNUSUAL HABITS

There are certain insects, such as the wire worm and cutworm, that live underneath the soil during their destructive stages. These have to be attacked by methods of cultivation. The poison remedy for cutworms will be found in the Manual on Agriculture.

There are still other insects that are difficult to combat by poisons, because they spend their destructive stage inside the food plant, where poisons cannot reach them. Examples of these are the Hessian fly—a serious wheat pest that spends its larval stage between the base of a leaf and the main stalk, and the tree borers, whose larval stage is spent in tunnels within the trunk of the food tree.

Special methods of cultivation are required for fighting these. For example, to fight the Hessian fly, plough under all wheat stubble, as soon as the crop is harvested, and delay planting the new crop until the egg-laying period of the fly is over.

By applying to the Department of Agriculture, Parliament Buildings, Toronto, one may learn, for each part of Ontario, the dates for sowing, in order that the wheat may escape the attack of the fly.

For details of preparation and application of poisons for the various types of insects, see *Ontario Teacher's Manual on Agriculture and Horticulture*, or Bulletins 250—*Insects Attacking Fruit Trees*, and 251—*Insects Affecting Vegetables*. These Bulletins may be obtained from the Department of Agriculture, Parliament Buildings, Toronto.

LESSON—THE ECONOMIC VALUE OF BIRDS

Preparation: A great observer has said: "If it were not for the birds, harmful insects would become so plentiful that our forest and orchard trees would be stripped of their foliage, and the grass and grain fields would be made as bare as a desert."

Problem: We will study the activities of birds to find whether this is true.

Presentation: Show in succession pictures of well-known birds that the pupils have already identified as, robin, oriole, songsparrow, wren, blue-bird, woodpecker, meadow-lark. As each picture is shown, discuss with the pupils where the bird lives and what its food probably consists of. This will bring out such facts as, the robins and the orioles get insects and grubs in the trees; the robin and the meadow-lark find them on the ground in

the grain and meadow-fields; the woodpecker gets insects and their eggs and larvæ from orchard and forest trees, while the wren and the blue-bird get insects and grubs from the gardens and roadsides.

Using pictures of the birds, compare the bill of the sparrow with that of the blue-bird or wren. The pupils will perceive that these bills are formed for doing different kinds of work. They will also reach the conclusion that the short, stout bill of the sparrow is better fitted for breaking open hard seed cases than is the slender bill of the blue-bird.

Seed-eating birds have short, stout bills. Insect-eating birds have long, slender bills.

By examining the pictures, find several members of each class.

Seed-eaters include sparrows, American goldfinch, grosbeaks, snow bunting or snowbird and others.

Upon what do snowbirds live when they are spending the winter with us? Since many weeds keep their seeds through the winter, these birds eat and destroy great quantities of the seeds of troublesome weeds.

Have you seen the American goldfinch, commonly called the wild canary, perched on a Canada thistle picking out the seeds? These seeds are its favourite food. From this fact it has earned the name "thistle bird!"

Question the pupils as to whether young birds grow quickly or slowly. Since they grow very quickly, they require a great deal of food when they are young, just as a growing boy does. A boy could not eat a sheep or a calf of his own weight in a day, but a young wren or a swallow eats more than its own weight of insects and grubs every day, and nearly all birds have quite as good appetites.

Now think of the great number of troublesome flies

and mosquitoes that a mother swallow or martin must catch every day, as she flies around from sunrise to dark gathering food for her hungry family of five or six children. This is the great service done for the owner of the orchard by woodpeckers, robins, orioles, and catbirds, all of which are constantly in search of the particular insects or larvæ that suit their taste.

Exhibit pictures of the birds in the following list that are not well known to the pupils.

Our forest trees have a whole army of thrushes, ovenbirds, tanagers, chickadees, and warblers fighting the insect pests that would strip the foliage from every tree and shrub if they ever gained the mastery.

No one has yet been able to give us the cash value to the farmer of each quail and meadow-lark that forages for bugs, beetles, and larvæ through the grain fields, meadows, and pastures from early spring until late fall, and yet many farmers permit sportsmen to slaughter these little helpers.

The pupils are next asked to give their opinions on the value of hawks and owls. So strong are the prejudices against these birds that it will be difficult to convince the pupils that these two groups have been much maligned. When a farm boy sees a hawk perched quite motionless upon a dead limb near the top of a tall tree, his impulse is to shoot the thief. The hawk is quite likely on the watch for a mouse, or squirrel, or rat. When its keen eye catches sight of the rodent moving upon the ground, it swoops down and kills and eats it. Of the many members of these two groups, only Cooper's hawk, the sharp-shinned hawk, and the great horned owl are poultry thieves; and even they steal poultry only when necessity forces them to do so.

Exhibit pictures of the three birds named in the last sentence. Discuss means of recognizing them.

A very interesting exercise is to hold a trial upon the birds which are viewed with suspicion or which are openly condemned as objectionable neighbours. One pupil is appointed to act as judge, and the other pupils give evidence. The evidence is based upon the pupil's personal observations, information learned by reading, or from the experiences of others.

The following birds are suggested for discussion in this way: The crow, robin, catbird, cowbird, hawks, owls, woodpeckers, bronzed grackle.

Birds of Ontario in Relation to Agriculture, by Nash, which may be obtained from the Department of Agriculture, Parliament Buildings, Toronto, is full of information on this topic.

CORRELATION

Read the following extracts from *The Birds of Killingworth*, Longfellow:

Do you ne'er think what wondrous beings these?
Do you ne'er think who made them, and who taught
The dialect they speak, where melodies
Alone are the interpreters of thought?
Where household words are songs in many keys
Sweeter than instruments of man e'er caught!
Whose habitations in the tree-tops even
Are half-way houses on the road to Heaven.

. . . . . .

You call them thieves and pillagers; but know
They are the winged warders of your farms,
Who from the cornfields drive the insidious foe,
And from your harvests keep a hundred harms.
Even the blackest of them all, the crow,
Renders good service as your man-at-arms,
Crushing the beetle in his coat of mail,
And crying havoc on the slug and snail.

ELEMENTARY SCIENCE

TYPE LESSON PLAN

To teach the expansion and contraction of solids owing to changes of temperature. (*General Method, Chap. I, page 26.*)

Materials: 1. Apparatus—An iron rod and a piece of heavy copper wire obtained by removing the insulation from a piece of heavy electric wire. (See Expansion of Solids by Heat, Experiment 1, page 192.)

2. A ball and ring. (See Expansion of Solids, page 192.)

Preparation: Discussion of what is done when a ring cannot be taken off a fruit jar. (Sec. 1, General Method, page 26.)

Problem: To learn why putting a hot cloth around the ring causes it to come off easily.

Presentation: What change does the hot cloth produce in the temperature of the ring? Can you suggest any other change that may have accompanied this, so as to cause the ring to come off?

The pupils suggest that water soaked in and loosened the ring.

The teacher may ask, What change must you make in a bracelet so that it will come off your wrist?

The pupils are guided to reason that the ring probably grew larger as it grew warmer. (Sec. 5, General Method, Chap. I, page 26.)

The teacher now requests the pupils to devise an experiment by which, through the use of apparatus, the class may find out whether solids grow larger when they are heated. The pupils handle and test the apparatus, and they discover a way to make the required test. (Secs. 2 and 3, General Method, Chap. I, page 26.)

A pupil is then selected to carry out the experiment, using the iron rod, (1) when cold, (2) when hot, (3) when cooled. (Sec. 4, page 26.)

After discussion of the results of the above tests, and recording them on the black-board, another student is selected to carry out the experiment, using the copper wire. Proceed as in the case of the iron rod, placing the results on the black-board.

After the pupils have completed the observations, the teacher, by questions, guides them to select the results that are common, and to make the following generalization (General Method):

Heat causes solids to expand, cold causes them to contract.

If there is a "Ball and Ring" apparatus, the following question may also be taken up:

In what direction does the solid expand?

The pupils are required to select the apparatus to be used to answer this.

A pupil who has not taken a previous part in the physical work of the experiment makes the test with the heated ball.

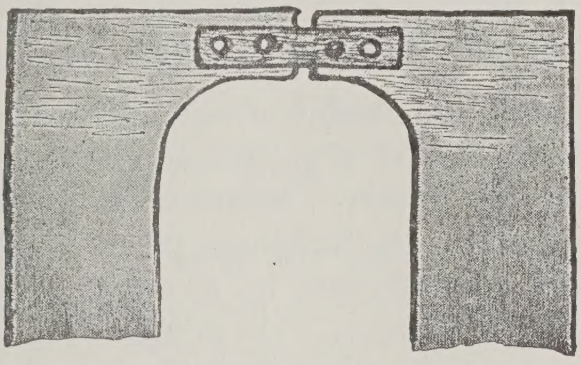
Conclusion: There is expansion in every dimension.

Question: In our lesson problem, why does the ring come off the fruit jar after the hot cloth has been applied?

Application: A mechanic is repairing a cracked iron plate by bolting on it a strap of iron as shown. (Draw it on the black-board.) Whether should he bolt the iron strap on when the strap is hot, or when it is cold? Give reasons.

Take up other applications. (See **Applications,** page 193.)

Seat work: Write descriptions of the experiment, with drawings of the apparatus.



Weather Records, Temperature, Direction of Winds, Rainfall, etc.

TEMPERATURE

The construction and use of the thermometer is discussed in connection with "Expansion of Liquids by Heat" (see page 195). To give accurate records of the outdoor temperature the thermometer should be suspended in a place where it is sheltered from the direct rays of the sun and from rain and snow, but it should be exposed freely to the atmosphere. A box nailed to a post can be made into a suitable thermometer shelter by boring holes through the sides and bottom and hinging one side to form a door. To prevent snow and rain from entering the holes bore them so as to slant upward from the outside, or better, nail projecting strips of wood or tin above them like little roofs.

For determining the direction of the wind, the pupils can make an arrow-shaped weather vane from a strip of

thin wood such as a shingle. They should bore a hole through it at its balancing point and fasten it by means of a nail to the end of a stick so that it can rotate freely. It can then be nailed to the top of a pole or to the ridge of the roof. If the wind is too light to turn the vane, the direction in which it is blowing can be determined by observing the drift of the smoke from a chimney.

To measure the amount of rainfall or snowfall use a cylindrical tin can for a gauge—an empty tomato can will answer the purpose. Fasten it in place near the ground, away from the buildings, trees, or other objects which might interfere with its receiving a fair amount of the fall of rain or snow. The precipitation (or rainfall) is usually stated in inches or decimals of an inch.

These and other simple weather records can be kept in chart form such as is given below. They should be preserved from year to year for reference.

Date		Temperature			Wind		Rainfall inc	Sky	Remarks
Month	Day	9 a.m	12 noon	4 p.m	Direction	Velocity	Inches		

Suggestions in Elementary Science

EXPANSION OF SOLIDS BY HEAT

Facts to be taught: That when a solid is heated it expands, and conversely, when it cools it contracts.

The usual experiments are those performed with the metal ball and ring and with some form of pyrometer which shows the elongation of a metal rod when heated.

Both of these experiments are described in the *Ontario High School Physics.*

A bolt which has a snugly-fitting nut is a very good substitute for the ball and ring apparatus. The bolt when cold can be screwed easily into the nut, but when heated it will not enter. A bolt of rather large diameter, say a half-inch or more is best, as its expansion is greater. Or two metal rings will serve the purpose, if they are of such sizes that one will just pass through the other when both are cold. Wire handles can be twisted on them.

Experiment: A pupil can readily construct an apparatus for this experiment as follows: Drive two nails into a board at such a distance apart that a rod of some kind will just fit in between their projecting heads. Then heat the rod (about fifteen inches in length), and try if it will still pass between the nails. A wire twisted around the rod will serve as a handle.

Applications: This expansion and contraction of solids is often used or taken into account in everyday life.

1. The blacksmith heats the iron tire of a wagon wheel to enlarge it sufficiently to make it slip over the wooden rim. He then cools it, and it contracts and fits snugly to the rim.

2. Boiler-plates and the steel plates of other structures are put together with red-hot rivets, which, on cooling, draw the plates together so as to form very tight joints.

3. The wire of farm fences is not straight, but is purposely made in waves or long spirals. In winter the wire contracts and straightens somewhat, and in summer it lengthens again and becomes more crooked, and so remains taut without breaking.

4. Railway rails are not placed with their ends in actual contact, but a little space is allowed between adjacent rails, so that they can expand in summer without throwing the track out of alignment.

5. Pavements and sidewalks made of concrete often crack across as they contract in cold weather. To prevent this it is customary to leave joints at intervals of a few feet, so that the blocks of concrete, like the ends of railway rails, are not touching each other.

6. Ice, being a solid, contracts as it further cools after freezing. This is why, in the morning after a very cold night, numerous irregular cracks often are to be seen running across the icy coating on sidewalks.

7. If hot water is poured into a thick glass tumbler, the glass is likely to break. The inner portions of glass expand before the change in temperature has reached the outer portions. Thus the inside becomes too large for the outside, and the glass breaks. If the glass is laid on its side in a pan and water is poured into the pan so that both the inside and the outside of the glass are heated at the same time, the glass is not likely to break.

EXPANSION OF LIQUIDS BY HEAT

Facts to be taught: That liquids expand when heated and contract when cooled.

These facts are commonly shown by filling a Florence flask with water and closing it with a one-holed rubber stopper through which passes a glass tube open at both ends. The flask and water are then alternately heated and cooled, and the rise and the fall of the water in the tube show the expansion or the contraction.

A bottle may be used instead of a flask, and an ordi-

nary cork and a straw instead of the rubber stopper and tube. Joints may be made tight with wax or gum. If the bottle has a narrow neck, no cork or tube is necessary. Simply mark carefully on a strip of paper pasted on the neck the height of the water before heating, and the rise will be easily seen, or fill the bottle full, and it will overflow when heated. To avoid breaking the bottle, heat it indirectly, by standing it in a vessel of water and heating the latter.

Just before freezing and while freezing, water expands to a remarkable extent.

A narrow-necked bottle may be nearly filled with water, the level of the surface of the water marked on the neck, and the bottle then set in a mixture of salt and broken ice, or better, merely set outside on the window-sill on a very cold day in winter. As the pupils watch they may see the water contract for a while, then expand again, and finally freeze and break the bottle.

Applications:

The most common practical application of this expansion and contraction of liquids is the ordinary thermometer. The class should be allowed to examine this instrument to see how it is constructed, and what liquid is used. If the thermometer is suitable, it should be placed in melting ice and in the steam rising from boiling water, to show how freezing-point and boiling-point are determined. If several thermometers are available, it is well to let the pupils compare them to see which ones are most accurate. Cheap thermometers are often incorrect by several degrees. Show also different forms of the instrument if available, such as a dairy thermometer and an incubator thermometer.

The expansion tank used at the top of a hot-water system of heating is necessary, because of the change in volume which the water undergoes as its temperature changes.

Let the pupils note the changing level of the water in the glass gauge attached to an expansion tank, and report their observations.

Ink bottles often burst in cold weather, since ink is chiefly water.

The careless motorist forgets to drain the water from the radiator of his automobile, and it freezes and bursts the radiator.

The crevices in rocks fill with water, and when it freezes the rocks are split apart.

Fall-ploughed land soaks up water, and by its freezing the soil is made mellow for spring work.

Since the volume of ice is greater than that of the water from which it was formed, a piece of ice is lighter than an equal volume of water and so floats.

EXPANSION OF GASES BY HEAT

Facts to be taught: Gases expand when heated and contract when cooled.

The same apparatus that is used to show the expansion of liquids can also be used to show expansion of gases. All that is necessary is to invert the flask and tube or long-necked bottle containing air over water in a tumbler and apply a hot cloth to the flask or bottle. The expanding air will bubble out. If now the flask is cooled, the air will contract, and the water will be forced up into the flask by air pressure.

If other gases can be prepared, such as hydrogen or

carbon dioxide, it should be shown that they, too, expand and contract as air does.

If a part of a mass of fluid be heated, it expands and becomes lighter than an equal volume of the surrounding cooler fluid; and the latter is able to push up the warmer lighter part just as the heavier water pushes up the light cork.

CHAPTER XIII

FORM IV

SPRING

PLANT STUDY

Simple Observations and Experiments on the Germination of Seeds

Materials:

1. Soak overnight in a dish of water a sufficient number of pea seeds, and also of bean seeds, to supply each member of the class with a seed of each kind.

2. The teacher should have a few seeds of each kind that have been germinating for about three days. The little plants in these will be sufficiently far advanced to be useful in helping the pupils to identify the parts of the embryo.

Preparation: Discussion with the class as follows:

If seeds are kept in a package in a drawer, while others similar to them are planted in the soil when the weather is warm, which seeds will produce young plants? Why do these produce plants? Where do these plants have their beginning?

Problem:

We will carry out certain experiments to help us to answer these questions.

Presentation: Discover where each part of the plant had its beginning in the seed.

Supply a soaked bean seed to each pupil.

Pupils examine the exterior of the seed, noting (1) the new, loosened *seed coat*, and (2) the small hole near the scar.

C, coat; Y, young plant; L, leaves; R, root

Ask the pupils to remove the seed coat carefully so as not to disturb what is inside. Describe briefly what is found inside, noting that it is made up of two parts.

Separate these parts very slowly and observe at what point there is a slight connection between them. The pupils examine the object found at this part, and identify the root part and the stem and leaf part of the young plant. The partly germinated seeds, if shown to them, will aid the pupils in identifying the parts.

The teacher can now give the name *seed-leaves* to the two large, fleshy parts of the seed. The pupils will remember that both these seed-leaves were connected to the little plant, and may be asked to suggest uses of the seed leaves to the plant.

If the suggestion is made that the seed-leaves are storehouses for food for the little plant, accept it.

Application: The pupil is then required to make a drawing showing all the parts that have been found. The model is, of course, the seed that he has been examining.

DEPTH AT WHICH SEEDS SHOULD BE PLANTED

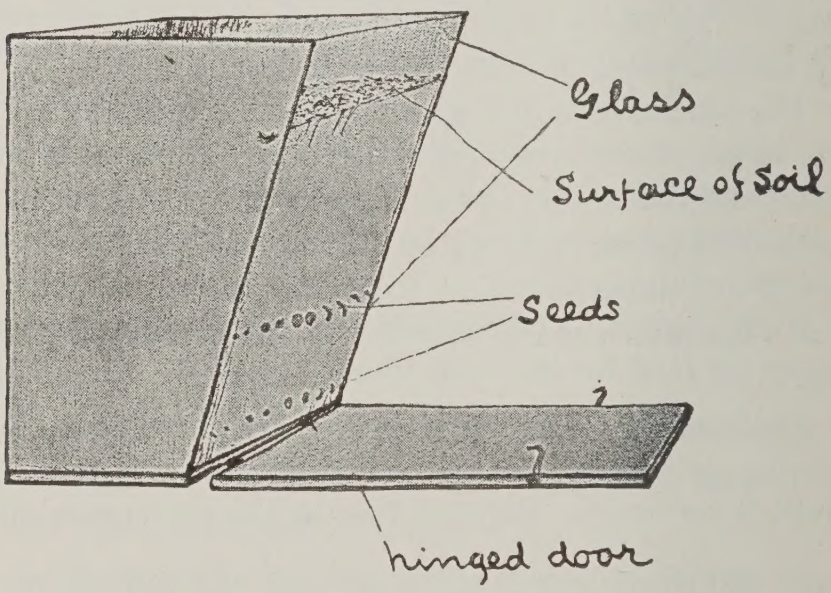
An experiment to discover how deeply seeds should be planted, and especially to learn whether there is any

relation between the size of a seed and the depth at which it should be planted.

Materials: A box with a glass front, a rectangular aquarium jar will do; clean sand; about thirty of each of the following sizes of seeds:

1. Very small, as timothy, snap-dragon, or nicotine,
2. Fairly small, as cabbage, millet, balsam, or radish.
3. Fairly large, as wheat, barley, or rye.
4. Large, as bean, corn, or squash.

Mark on the edge of the box the point where you intend the surface of the soil to be when the planting is complete. Measure downward from this point the following distances, and mark these on the edge of the box: One-fourth inch, one-half inch, one inch, two inches, four inches, and six inches.



Fill the box with sand to the six-inch mark. Place four seeds of each kind on the surface of the sand and

touching the glass. By putting the edge of a sheet of stiff paper where glass and soil surface meet, the seeds may be rolled down the paper to the required position. Next fill the box to the four-inch mark. Plant four seeds of each kind at this depth. Continue until seeds have been planted at all the depths named. Finally, place seeds on the surface of the sand. Moisten the sand and place the box in a suitable place for the germination of seeds. Make observations and record them, using the following schedule:

Relation of Size of Seed to Depth of Planting

Kind of Seed	Timothy	Millet	Wheat	Bean
Depth planted	0″	0″	0″	0″
Days before plant appeared				
Days before plant reached the surface				
Vigour of plant				
Depth planted	¼″	¼″	¼″	¼″
Days before plant appeared				
Days before plant reached the surface				
Vigour of plant				
Depth planted	½″	½″	½″	½″
Days before plant appeared				
Days before plant reached the surface				
Vigour of plant				

Similarly for the remaining depths of 1', 2", 4", 6"

Problems:

1. What will be the result of planting seeds too deeply?

2. Compare the depth at which small seeds, like timothy or lettuce, and large seeds, like beans, should be planted.

3. State the proper depth for planting each of the following: Timothy, millet, wheat, beans, snap-dragon, cabbage, rye, corn?

IDENTIFICATION OF COMMON WILD FLOWERS

The flowers which the pupils learned to identify in Forms I to III should be reviewed in Form IV. The methods of identification that were employed in the lower Forms may be continued in Form IV, but it is desirable that the pupils of the latter class should be taught some means by which they can identify flowers without the help of a teacher. When they have been put into possession of such a means, the number of flowers the pupils can learn to know is not limited by the brief time that can be spent upon this work in the school-room, but only by the time they are willing to spend upon this very inviting branch of nature study throughout the remainder of their lives.

As the use of the technical botany key is too difficult even to be thought of for the use of Form IV pupils, a wild-flower guide, with good pictures illustrating the flowers, is the best help to put into their hands. Many such books are obtainable, some of them at low cost. One of the best for the beginner is *Wild Flowers East of the Rockies*, by Reed, published by Musson & Co., Toronto. This book contains clear pictures, in colour, of nearly four hundred of the commonest wild flowers. It may be urged as an objection that four hundred is a limited number; but to state a test case—forty flowers

suitable for identification by Form IV were listed, and out of this number all but two were found to be illustrated in this book.

A few copies of Reed's book and a copy of *Nature's Garden*, by Neltje Blanchan, should be in the library of every school in which nature study is taught.

LESSON: USE OF A FLOWER GUIDE

Before the lesson the pupils have been instructed to bring wild flowers, if possible a flower for each member of the class, and one complete plant. In almost all instances fewer flowers will suffice. The pupils who bring flowers must be prepared to describe the habitat, that is, to tell whether the plant grows on rocky, marshy, or dry soil, whether in fields, or in forests, etc.

We will assume that the first flower to be studied is the Adder's Tongue. The observations of the pupils are so directed that they perceive the features that are important for the identification of the plant, namely, the *single*, *yellow* flower at the top of a *long*, *slender* stem, and the *two blotched* leaves *sheathing* the base of this stem. A flower and plant having these characteristics is sought for among the illustrations. The pupils will learn that in order to distinguish the adder's tongue from such wild flowers as bellwort and clintonia, all three having flowers very much alike, the features of the leaf and stem must be taken into consideration.

Two or three plants can be identified during a lesson period. The pupils are expected to find in their habitats all the plants that are identified in the class room. Pupils should also be encouraged to identify as many plants as possible, independently of the class room.

The results of the work in plant identification should be recorded in the pupils' note-books according to the following schedule:

WILD FLOWER RECORDS

Date when studied in class	Name of plant	Drawing	Colour of flower	Date when seen in habitat

Wild flowers suitable for identification by Form IV:

Skunk cabbage, bloodroot, wild ginger, adder's tongue, bishop's cap, false mitrewort, common wild violets, Solomon's seal, false Solomon's seal, meadow rue, bellwort, Jack-in-the-pulpit, blue flag, wild phlox, beard's tongue, Sweet Cicely, bellflower, muskmallow, ferns as a class.

ANIMAL STUDY

Identification of Birds

In the lower Forms only the commonest and most noticeable birds were identified. Even if the lists of birds given for identification by these Forms have been completed, there still remain many common and conspicuous

birds that Form IV pupils can study without searching far afield. Among these are the wrens, swallows, thrushes, warblers, the scarlet tanager, ovenbird, horned lark, bobolink, American redstart, chickadee.

Burroughs, the naturalist, was once invited to assist some young friends in identifying some birds, a labour with which they were having great difficulty. He refused on the grounds that that would be making nature study too easy for them, adding that what they learned by the hardest work they would appreciate more when it was learned, and would also remember it better. He, himself, when identifying birds, visited their haunts frequently and made untiring study of their habits, songs, and nests, as well as of their size, form, and colour.

There is more real nature study in learning the identity of a few birds in this way than in looking superficially at many birds and being told the name to attach to each. In one case the learner comes to know the *bird* intimately, in the other to know little more than the name. Encourage the pupils of Form IV to delve more deeply into the secrets of bird life, and from the facts learned by observation to identify the birds from pictures and naturalists' descriptions. See method for Form III, page 138.

BIRD FAMILIES: THE SPARROW

The sparrows are a numerous family, and with the exception of the common English sparrow, all the members are useful as insect destroyers and consumers of the seeds of noxious weeds.

The size, build, and colouring of the many kinds of sparrows extend through such a small range that a member of the family can be readily identified by any one who has learned to know a few of its members.

The sociable little chipping sparrow that haunts the

dooryards and picks up crumbs that are thrown to it is one of the smallest of the family, being only 5.3 inches long. The fox sparrow, which lives in the thickets at the margins of swamps and is so shy and retiring that very few persons ever see it, is the largest, having a length of 7.2 inches. When we reflect that between these two extremes there are about ninety kinds of sparrows, with almost that number of grades of size, we realize that the range in size is truly not very great.

The amount of variation in the colouring throughout the family is almost as small as that of size. The prevailing colours are mottled grayish-brown and mottled brownish-gray, with a daub of buff in this species, or of brown, or black or white lines in that. All have the short neck, firm shoulders, and short, stout beak peculiar to seed-eaters.

Many members of the family are excellent singers. Prominent among these are the song sparrow, the vesper sparrow, and the white-throated sparrow. The whistled song of the latter bears so little resemblance to that of nearly all other sparrows that it is difficult for the beginner in bird study to believe that it is the song of a member of the sparrow family. From the woods bordering on swamps there may be heard from early spring till late summer the ringing whistle of the white-throated sparrow. The song has been interpreted by the words "Old Tom Peabody, Peabody, Peabody!" A story is commonly told in the New England States about a farmer whose name was Peabody. One spring this farmer was in a quandary as to whether he should sow wheat or corn in his fields. When in the field, pondering upon his problem, he heard a whistling voice advising him, "Sow wheat! Peabody, Peabody, Peabody!" In the New England States this bird is known as the Peabody.

For the nature student, an interesting exercise is to practise imitating the song of this sparrow until the notes are so accurate that they deceive the bird. One bird student who had tried in vain for weeks to find the source of the Peabody song, and had come to much the same state of mind as Wordsworth was in when he wrote:

> Oh Cuckoo! shall I call thee Bird,
> Or but a wandering Voice?

hit upon this as a means of getting close enough to the bird to identify it.

Less than twenty species of sparrow are found in Ontario. Of these the English sparrow, the song sparrow, the chipping sparrow, and the vesper sparrow are probably the best known.

THE VESPER SPARROW STUDIED AS A TYPE

In the month of June go into the meadow or pasture field and listen for a clear, joyous song that somewhat resembles that of the song sparrow. This song is most frequently heard late in the afternoon, and is continued into the twilight. Approach the bird very slowly and by walking as though you intend to pass by. When you are close enough to see it clearly, look for the mottled gray and brown of the sparrows. If these are the colours and the shoulders are reddish-brown, and especially if, when the bird flies away, it shows a white stripe along each margin of its tail, you will know that you have made the acquaintance of the vesper sparrow.

You may be sure that his mate and nest are somewhere near. Every day you may hear him and see him at the same spot, while his mate sits on the four or five eggs (white with brown spots), in a nest made of soft, dry grass and hidden at the base of a thick tuft of weeds or grass.

THE SWALLOWS

No bird family is more convenient for studying than the swallows, and none repays us more promptly for any interest we take in its welfare. The members of this family do not hesitate to forsake the solitudes that they may cluster around the homes of mankind. In our study of the swallows let us try to discover in what ways they and man are mutually helpful.

It makes little difference whether we study as our type the purple martin—the overgrown member of the family, the barn swallow, which is of average size, or the cliff swallow (sand martin) which is the midget, for they all have very pronounced family resemblances.

Viewed from a distance, either when at rest, or when flying, they all appear to be of a blue black colour. On closer inspection different degrees of blackness are distinguishable in the decorative colouring, which makes it rather easy to distinguish one species from another.

Observations: Watch any member of the family and describe the shape of the wings and also the peculiarities of the movements of flight.

What purpose have the swallows in this flight? Watch closely to find the answer.

The poet, Scott, likens the motion of Marmion's horse in the escape from Tantallon, to a swallow, in these words:

> Nor lighter does the swallow skim
> Along the smooth lake's level brim.

What idea did the poet wish to express?

Describe the length, stoutness of the beak, and the size of the open mouth.

What is the use of the circle of bristles that form a funnel around the mouth when it is open?

Examine the inside of the mouth, and you will probably find a number of insects there. Use this discovery in explaining the fitness of the swallow's mouth for securing food while it is flying.

The insects referred to include many that are troublesome to man and to domestic animals, such as, mosquitoes, house-flies, stable-flies, cattle-flies, gnats, and ants.

We already know something of the mutual helpfulness of swallows and man. The cleared land makes a better hunting-ground for the swallow than the forest, not only because it permits of greater freedom of flight and greater range of vision for sighting the prey, but also because it furnishes a greater variety of insects.

The nests also, no matter how they differ in detail, have something in common that causes structures made by man to serve as suitable supports and protections for them. Thus the perpendicular face of a sand pit or gravel pit is usually a more suitable site for the tunneling operations of a sand-martin colony than the natural bank of a river; underneath the eaves of a barn or shed the cliff swallow finds a more secure place to build his mud home than the shelving face of a cliff affords, and the purple martin readily accepts the "martin house," with its six or eight apartments, as an ideal spot to gratify his instinct for living in colonies. So strong is the gregarious instinct of all the swallows, and so smoothly do they fly, that the lines of Charles G. D. Roberts, the Canadian poet and naturalist, are apt:

Little comrades of the sky,
Wing to wing we wander by,
Going, going, going, going,
Softly as a sigh.

LESSON I: THE TOAD

A discussion to arouse interest should be held, based on such topics as the following:

1. What places are frequented by toads—
   (1) In early spring?
   (2) In dry weather during the summer?
   (3) In the evenings during the summer?
   (4) In ordinary summer weather?
2. Describe and explain the behaviour of a young dog that seizes a toad in his mouth.
3. What are noticeable differences between a frog and a toad?

The discussion will deal with such points as—

(1) The toad is brown or gray, the colour resembling the soil in which the toad lives. The frog is greenish, the colour resembling the grass or weeds in which it lives.

(2) Toads are of a lower, flatter build than frogs. The advantage of the toad's form will be learned when studying its burrowing habit.

(3) Frogs are more aquatic and more active than toads. Toads escape their enemies by their ability to hide, frogs principally by their activity and by their swimming and diving powers.

(4) Toads are rougher than frogs. Connect the observation of the warts with the experience of the dog seizing the toad.

LESSON II: THE TOAD

A lesson to help the pupil to discover the meaning of the characteristics of the toad that were discussed in the first lesson.

Put a garden toad into a box covered with a pane of glass or a piece of gauze. There should be about three inches of loose, moist, garden loam in the bottom of the box; also a piece of board, supported at each end, so as to form a space above the soil about an inch deep under wh ch the toad can hide.

OBSERVATIONAL STUDIES

1. Describe the toad's burrow.

2. Does it go into the burrow forwards or backwards?

3. Why is it difficult to see the toad when it is in the soil?

4. When does it move about freely hunting for food?

By making the surface of the soil very soft and smooth in the evening, we can learn whether the toad moves about at night.

5. How are the eyes of the toad fitted for keeping a lookout in all directions?

Describe the colour of each part of the eye.

6. How are the feet and legs of the toad fitted for burrowing, swimming, hopping?

7. After the toad has been in the box for several days, it will be hungry. Fasten a moth or grub or small piece of meat to the end of a fine thread and swing it past the toad's nose and at a distance of about an inch from it. Be alert to see all that takes place.

FIELD EXERCISES TO FOLLOW OBSERVATIONAL STUDIES

1. Watch a toad on a lawn under a street light, and learn what insects it catches, how it catches them, and the average number caught in five minutes.

2. If you live near a sandy beach, in the morning study

the night wanderings of a toad by following the records of these in the soft sand.

3. What colour are the toads that live in gray, sandy soil? What colour are those that live in black soil? Transfer a few from one locality to the other, and discover whether the colour changes after the toad had been in the new surroundings for some time.

To the Teacher: The toad works its way into its burrow by a backward motion. Its colour and rough skin harmonize so perfectly with the soil that it is well concealed.

Toads do not cause warts: but glands in the skin secrete a fluid that is very irritating to the mouth of any animal that seizes the toad with its teeth. This fluid is harmless to the skin of even a young child.

Toads are nocturnal in their habits. Favourite hunting places in towns and cities are under the electric lights, which attract large numbers of flies, beetles, and mosquitoes. These, together with grasshoppers, crickets, caterpillars (even hairy ones), and cutworms, form the greater part of the toad's menu.

The tongue of the toad is marvellously constructed for catching insects. It is fastened at the front of the mouth, while the inner end is free. This end can be shot out with lightning speed, and its end is so sticky that any insect touched by it has little chance of escape.

The hind legs of the toad are adapted to a variety of uses. The length, the strong muscles, the arrangements of the parts into a system of levers, makes it possible for the animal to take long, quick hops. The five toes are connected by a web, making a very efficient swimming organ; and the short, strong spur of hard horn-like material, just back of the first toe, is very useful for digging.

THE EARTHWORM

Time: May or June, in connection with gardening, when the working of the worms in the moist soil of the garden is quite noticeable.

Outdoor studies may be assigned as follows:

Observe the loose soil at the entrance to the burrows. Insert a straw in the burrow and, following it, dig downward with a garden trowel and learn the nature of the earthworm's home.

When are earthworms ever found out of their burrows during the day? Why do they burrow deep in dry weather?

Earthworms can breathe only when the surface of their bodies are kept moist.

Go out at night with a lantern to where earthworms are known to have burrows, observe the worms stretched out with the rear ends of their bodies attached to the burrows, and note how quickly they draw back when they are touched. What movement do they make if the ground is jarred near them? What happens when the light of the lantern falls upon them?

State the facts which are taught by the observations made on the above topics.

CLASS ROOM LESSON

Put two or three earthworms into a jar of rich, damp soil, on top of which there is a layer of sand a quarter of an inch thick.

Put bits of cabbage, onion, grass, and other plants on the surface and cover the jar with a glass slip or cardboard.

After a few days examine the jar, noting the number of burrows, the foods selected, the castings, the food dragged into the burrows. Pour water into the jar and observe the actions of the worms. Can an earthworm live in water?

Place an earthworm on a moist plate or board and direct the pupils to study it as follows:

Distinguish the head from the rear end, the upper from the lower side. Observe the means of locomotion. To assist in making the latter observation stroke the worm from rear to head and find the four double rows of bristles. Why is it difficult to pull an earthworm out of its burrow?

Find the mouth. Has the earthworm any eyes, ears, or nose? Stick a pin upright in the path of a moving worm and try to explain why it turns aside before touching the obstacle. Test the sensitiveness to feeling.

From the soil castings found in the jar, infer the value of earthworms for enriching and pulverizing the soil.

CHAPTER XIV

FORM III: SUPPLEMENTARY COURSE IN SCIENCE

OBSERVATION OF NATURAL PHENOMENA

THERE are many frequently occurring natural phenomena which can be explained only by the application of some of the principles of Physical Science. Such phenomena should be used as the bases of lessons if they can be made simple enough to be comprehended by the pupils.

MOISTURE IN THE AIR

For example, the occurrence and formation of fog, clouds, dew, rain, frost, and snow are associated with evaporation and condensation, and illustrative experiments can easily be performed.

1. Sprinkle a little water on the floor or rub a wet cloth over the black-board; in a few minutes the moisture will have disappeared by evaporation.

2. Put a little water in a tin dish and heat it. Gradually the water becomes less and, finally, is all gone.

3. Watch the steam issue from the spout of a tea-kettle. Note that near the spout it is invisible, then becomes visible as a small cloud, and then vanishes as it floats away.

4. Notice how the vapour in the room condenses and becomes visible again if an outside door or window is opened on a cold winter day.

5. Allow the steam from the kettle to flow into a large

bottle wrapped with a cold, wet cloth, and so condense the vapour to liquid water again.

6. Breathe on the window-pane to make the moisture in the breath visible; if the glass is cold enough it may be turned to frost.

Such experiments performed by the pupils and thoughtfully discussed with them will lead to a clearer understanding of the causes of the natural phenomena mentioned.

REFLECTIONS AND SHADOWS

In the same way experiments in shadow formation, by the use of a candle flame as the source of light, will help to the understanding of eclipses of the sun and moon; reflection of light from a mirror will assist in comprehending how the moon and the planets shine by reflected light from the sun; and passing a beam of light from the sun through a prism will illustrate the formation of the rainbow.

SOLUTIONS

Natural and artificial solutions are of such importance that the pupils ought to be taught the principles underlying the preparation of them. The chief facts to be presented are:

1. That many solids (but not all solids) are soluble in water and usually more soluble in hot water than in cold.

2. That many liquids and gases are soluble in water, but that gases are less soluble in hot water than in cold.

3. That some substances which are not soluble in water can be dissolved in other liquids.

4. That, by evaporating the solvent, a dissolved solid can be regained.

Experiments:

1. Have the pupils measure, or better, weigh out equal quantities of sugar, salt, soda, alum, blue vitriol, or other soluble solids. Shake them up with equal quantities of water to compare solubilities.

2. Repeat the experiment, using hot water to see whether more of the solid will dissolve.

3. Set out the solutions in saucers on the table to evaporate, or evaporate them rapidly over a stove or lamp.

4. Try to dissolve sand, sulphur, charcoal, in cold and in hot water.

5. Shake up some ordinary loam soil in water, filter it or let it stand until the liquid is clear, then evaporate a little of the clear liquid on a piece of glass or a saucer. Examine the glass for a residue of material which has been dissolved.

6. Obtain a few crystals of iodine and show how much more readily they dissolve in alcohol than in water.

7. Gently heat some water in a test-tube or bottle, and observe the bubbles of air that gather on the inner surface of the bottle. A better way is to invert a full test-tube of water in a beaker of water, and heat that part of the tube which projects above the surface of the water in the beaker. The air bubbles will collect, to form a single large one, and will remain undissolved for a long time.

Applications:

1. Salt is obtained from sea water or from the brine of salt wells by evaporation.

2. Maple sap is water containing sugar in solution. When the water is evaporated, the sugar remains as a

solid. Similarly, the sugar in sugar-cane and sugar-beets is removed in solution and then recovered by evaporating the solvent.

3. The food materials in the soil enter the plant only in solution.

4. Most of the essences, tinctures, and spirits are alcoholic solutions.

5. Soups and broths are solutions of certain materials contained in meat and vegetables.

6. The solvent power of water makes it very valuable for washing. Adding soap increases its solvent power.

7. Grease is not soluble in water; hence it is best removed from clothing by benzine or gasoline.

8. Aquatic animals, as fish, clams, crayfish, and crabs, breathe the air that is dissolved in water.

NATURE OF SOLIDS, LIQUIDS, AND GASES

Facts to be taught: That a solid has a shape and a volume that are not easily changed, that is, it has a definite shape and a definite volume.

That a liquid has a volume that is not easily changed, but depends for its shape upon the containing vessel; that is, it has a definite volume but an indefinite shape.

That a gas has a volume and a shape that are easily changed; that is, it has an indefinite volume and an indefinite shape.

Experiments:

1. Arrange a collection of objects of various shapes, sizes, colours, and weights, as cork, glass, lead, iron, copper, stone, and chalk. Lift each and note that each object moves as a whole; squeeze each and see that its shape and its volume are not easily changed. Such objects are called solids.

2. Now take such substances as water, alcohol, oil, molasses, mercury, honey, and gasoline. Try to lift these and note that they cannot be handled unless in a containing vessel. They will flow, and they depend for their shape upon the containing vessel. They are called liquids.

3. To show how air differs from liquids use a small bicycle pump. The air in the pump can easily be compressed to half its volume or less, but if the pump barrel be filled with water, the liquid is found to be incompressible.

4. Put a few bits of copper in a test-tube and add a little nitric acid. Watch the formation of a brown gas, and note how it falls through the air and spreads in all directions, filling an indefinite space.

(Experiments 3 and 4 show that while liquids have a definite volume, gases have not. Because liquids and gases both flow they are called fluids.)

5. The same substance may exist in two or more of these states. Heat some solid wax or lead in a spoon until it melts and becomes a liquid. Let it cool again, and it becomes a solid.

Heat some solid ice until it becomes liquid water, and then heat the water until it becomes gas (steam). Hold a cold cup or tumbler over the steam, and it cools again into a liquid, and this in turn can be frozen into the solid ice.

Applications: Relate these changes of state to distillation, formation of dew and rain, formation of lava and igneous rocks, and moulding iron.

CHAPTER XV

FORM IV: SUPPLEMENTARY COURSE IN SCIENCE

OBSERVATIONS OF NATURAL PHENOMENA

Air Pressure

Facts to be taught: That the atmosphere exerts pressure upon all surfaces which it touches; that this pressure is exerted in all directions, upward, downward, and sideways.

Experiments:

1. Fill a tumbler with water and invert it in a vessel of water, then raise it, keeping it mouth downward. So long as the mouth of the tumbler is below the surface of the water in the vessel, the tumbler will remain full, the water being held in the tumbler by the downward pressure of the air on the surface of the water in the vessel.

2. Fill or partly fill a tumbler with water and place over its mouth a piece of writing paper. Holding this paper in place with the palm of the hand, invert the tumbler and then remove the hand from the paper. The water remains in the tumbler, held there by the upward pressure of the air on the paper. This pressure forces the central portion of the paper upward, so that its surface, as seen from below, is concave.

3. An interesting experiment showing clearly the force of air pressure can be performed with an empty can which has an opening that may be tightly closed with a cork. A varnish can of a quart or more capacity does very

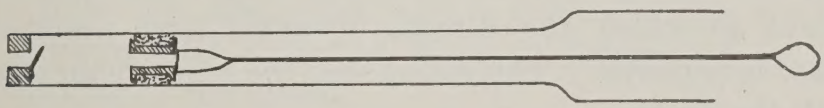
well. Put water in the can to the depth of about half an inch, and boil it for a few minutes until the steam has expelled most of the air from the can. Then cease heating the can and immediately close its opening tightly. As it cools the steam it contains condenses to water. Since the water occupies much less space than the steam did, the pressure of the air within the can is lessened, with the result that the pressure of the air on the outside of the can soon crushes it inward. This result may be hastened by pouring cold water over the can as soon as it has been tightly corked.

THE BAROMETER

The barometer is the instrument used to measure this air pressure. For a description of the instrument and explanation of its use see the *Ontario High School Physics* and the *Laboratory Manual* which accompanies it.

Application: The common pump is a practical application of air pressure. A working model is easily constructed as follows: Take a glass tube, such as a straight-sided lamp chimney, and fit within it a piston made of a spool wound with soft cord. Attach a bent and twisted wire to the spool as a handle to raise and lower the piston. Fit a perforated cork into one end of the chimney, and valves made of small bits of rubber or oilcloth cover the upper ends of the holes in the cork and the spool.

The diagram shows the construction.



The siphon is a simple instrument which depends upon atmospheric pressure for its action. If glass or rubber

tubing is not at hand, use large dandelion flower-stems joined by slipping the small end of one into the large end of another until a tube of sufficient length is made.

How is air pressure applied in filling a fountain pen? How is it applied in retaining the water in the drinking fountains often used for poultry? How is the supply of oil kept in the large tank of a coal-oil stove, and fed into the small tank and burners only as needed?

LIQUID PRESSURE

Facts to be taught: A liquid exerts pressure upon all surfaces which it touches. This pressure is exerted in all directions, upward, downward, and sideways.

This pressure increases with the length of the column of liquid above the surface upon which it presses.

Experiments:

1. Thrust a lead-pencil or any light stick endwise into a pail of water, and release it. The water will push it up almost or quite out of the water.

2. If an empty tin can is pushed down into water (either mouth or bottom downward), the upward pressure will be felt.

3. Punch a hole through the bottom of the empty can and thrust it into the pail of water, bottom downward. A stream of water will be pushed up through the hole into the can.

Close the hole by placing the tip of the finger over it. Sink the can to various depths; at each depth note the height to which the stream of water rises when the finger is removed. This shows that the pressure increases with the depth.

4. Punch a hole, with a small nail, through the side of a tin can near the bottom, then fill the can with

water. The water will be pushed out sideways in a stream. If three holes are punched, one near the top, one near the bottom, and another midway between these, the different lengths of the issuing streams of water will show that the pressure sideways increases with the depth.

Applications:

1. A water supply is often stored in an elevated tank or in a reservoir on a hill and conducted in pipes to where it is used. The higher the tank or reservoir the greater the pressure.

2. A dam must be much stronger at the bottom than at the top, to withstand the greater pressure due to the depth of the water.

OXYGEN

Facts to be taught: The atmosphere is composed partly of a gas called oxygen, which supports combustion and life.

Experiments:

1. Burn a candle in a fruit jar which is covered loosely with a piece of glass or a card. Note that after a short time the candle is extinguished. Now lift the cover and quickly thrust in a burning match or splinter. Since it is at once extinguished, it is evident that the gas remaining in the jar is not the air.

2. Set a lighted candle in a dish containing water to the depth of half an inch, and cover it with a pint fruit jar. Note that the water rises a short distance in the jar, showing that a part of the air is being used up by the burning of the candle.

The names *oxygen* and *nitrogen* may be given, and the pupils may be told that these gases occur in the air in

the proportion of about one of oxygen to four of nitrogen by volume.

Explain that a sort of burning goes on in the living body, and so a constant supply of oxygen is necessary. This is taken in by breathing, hence the importance of fresh air and ventilation.

In schools that have the necessary apparatus and chemicals, jars of oxygen should be prepared by the method described in the Chemistry text-book, and the pupils shown that anything that will burn in air will burn in oxygen, and do so much more vigorously. It may be shown, also, that some substances, such as iron picture-wire, which ordinarily will not burn in air, will burn in oxygen.

Applications:

1. The oxy-acetylene flame so much used in garages is a practical application of this vigorous burning when pure oxygen is used. The heat produced is so intense that it will melt metals, and so weld them together.

2. Pure oxygen is sometimes administered to persons who are sick; this is done especially in cases of pneumonia, where the breathing area of the lungs has been reduced, and in cases of asphyxiation.

3. Aviators who intend to reach high altitudes where the air is highly rarified carry cylinders of compressed oxygen and breathing helmets to supply their needs under the unusual conditions.

CARBON DIOXIDE

This gas is so closely associated with animal and plant life and is so easily prepared and handled that it can be made the basis of very valuable and interesting lessons in any school.

Facts to be taught:

1. That it can be prepared from washing-soda or baking-soda and vinegar.

2. That it does not support combustion (nor, by inference, life).

3. That it turns lime-water milky, and by this means can be easily detected.

4. That it is produced by the burning of wood, wax, oil, etc.

5. That it is given off by animals and plants in their respiration.

6. That it is used up by green plants to form part of their food.

Experiments:

1. Prepare a jar of the gas by pouring vinegar on a teaspoonful of baking-soda or washing-soda in a tumbler or fruit jar which is covered loosely. Lower a lighted candle or match into the jar and note that it is at once extinguished.

2. Vary this experiment, by placing a short candle at the bottom of a tumbler and then pouring in carbon dioxide from the larger jar in which it was prepared. As the carbon dioxide fills the tumbler, the candle is extinguished. This shows that the gas, though invisible, is heavier than air and pours like water. On account of its weight, the gas often collects in the bottom of old wells, mines, and tunnels. It is dangerous there, since it will not support life.

3. Procure some lime-water or prepare it by stirring slaked lime into water and allowing it to settle. Carefully pour off the clear liquid for use.

Put a little lime-water into a tumbler and pour in some carbon dioxide. Shake the gas and lime-water

together and observe that the latter becomes milky. Pupils are to understand that this milky colour will be considered the test for carbon dioxide.

4. Burn a bit of candle or a piece of wood or charcoal in a covered tumbler for a few seconds, then remove it and test the gas in the tumbler with lime-water. Hold the mouth of a bottle over a lamp or alcohol flame for a few seconds, then test the contained gas.

5. Have one of the pupils cause his breath to bubble through clear lime-water for a few seconds. Using a bicycle pump, cause some of the air of the class room and some outdoor air to bubble through lime-water. What do the experiments show as the comparative amounts of carbon dioxide present in the air from these three sources?

6. Invert a large jar over a leafy plant. Place beside the plant under the jar a small open vessel containing a little lime-water. Keep these in the dark for a day or two. Then note that the lime-water becomes turbid, showing that the plant has given off carbon dioxide. This is a product of respiration of the plant, just as in Experiment 5 it is shown to be a product of respiration of human beings.

Explain that green plants take in carbon dioxide to make food for themselves, and that this is the reason the amount of carbon dioxide in the atmosphere always remains so small that it is not injurious to an mal life.

Applications:

1. Baking-soda and some acid substance, as sour milk or cream of tartar, are used in making biscuits, because the carbon dioxide produced will cause them to "rise." Baking-powders contain substances that produce carbon

dioxide when water is added. Demonstrate this by stirring a little baking-powder into some water and testing the gas.

2. Soda-water and similar drinks are chiefly flavoured solutions of carbon dioxide in water. Uncork a bottle of ginger ale, shake the bottle, and test with lime-water the gas that comes off.

3. Many portable fire-extinguishers put out a fire owing to the generation of carbon dioxide when they are used.

CAPILLARITY

Facts to be taught:

1. Water rises in small tubes and in porous substances higher than its free surface.

2. The smaller the tubes or pores, the greater the height to which the water rises.

Experiments:

1. Hold one edge of a blotter in water and watch it rise into the paper.

2. Partly fill a tumbler with water, stand it at the edge of the table, and arrange a strip of cloth over the edge of the tumbler, so that one end dips in the water and the other hangs down lower than the top of the table. This "capillary siphon" will gradually empty the tumbler.

3. Take two similar pieces of clean window-glass, and place them face to face with a rubber band or string to hold them together. Then, by means of a small wedge, keep them a small distance apart at one edge while they touch at the other. Stand the plates in a dish of water with the edges that are in contact vertical. The water at once rises between the plates, highest at the

edge where the plates meet, and lowest where they are held apart.

4. Stand a lump of loaf sugar on edge in a saucer and heap on it some powdered sugar. Then pour a little water into the saucer, and the water will rise rapidly through the compact lump, but slowly through the loose powder.

Applications:

1. Blotters, towels, sponges, and mops owe their usefulness to capillarity.

2. The oil rises through the wicks of lamps by the same action.

3. Capillarity draws moisture from underground veins of water toward the surface. To aid this action the farmer tills the soil well, to make small particles, and rolls it to make the spaces small between them.

In order to check capillary action in the surface layers of the soil and so prevent too great evaporation in dry weather, the surface is kept well loosened by cultivation, to maintain large spaces in these layers.

OSMOSIS

Facts to be taught:

If two solutions, or water and a solution, be separated by a vegetable or animal membrane, each will diffuse through the membrane and mingle with the other, but the weaker solution passes through much more rapidly than the denser.

Experiments:

1. The experiment in which an egg membrane is used can be done in any school. Chip away the shell from the larger end of an egg, so as to expose a circle of un-

injured membrane from a half-inch to an inch in diameter. Carefully make a hole in the small end large enough for a quill or a straw to pass through and into the egg for half an inch. Fasten this tube in place with wax or chewing-gum, completely closing the hole around the tube. Support the egg on a wide-mouthed bottle filled with water, so that the exposed membrane is below the surface of the water. In a few hours the contents of the egg will have risen in the tube several inches.

Variations:

1. (*a*) Omit the tube; in which case note that the egg overflows.

(*b*) Without making any hole in the small end, immerse the egg wholly in a vessel of water supporting it with the large end upward, and note the bulging and stretching of the membrane.

These observations show that water has entered the egg through the membrane.

To show that some egg has passed into the water, heat the latter and see the cloudiness caused by the cooking of the white of egg. If the water can be tested with silver nitrate solution, it will be found to contain more salt than ordinary water.

2. Another easily performed experiment uses a potato. Hollow it out to form a cup, partly fill this cup with red ink, or sugar solution, and stand it in a vessel of water so that the liquid inside and the water outside are at the same height. In a few hours the liquid in the potato will have risen, and the water in the vessel will be slightly reddened or will taste of the sugar.

Note that in every experiment the more rapid transfer is toward the denser solution.

Applications: Much of the interchange of fluids between cells in both plants and animals is due to osmosis.

1. The water in the soil containing mineral substances in dilute solution is separated from the denser contents of the root hairs by the very thin membrane forming their walls. Consequently, the soil water passes into the roots, while little cell sap passes out.

2. Osmosis also partly accounts for the passage of sap from cell to cell through roots, stems, and leaves.

3. In the lungs the air inhaled into the air cells is separated from the blood in the capillaries by the thin walls of the capillaries and cells. Thus the oxygen passes freely from the air cells into the capillaries, and the carbon-dioxide in the reverse direction by osmosis.

SOURCES OF HEAT

Facts to be taught:

1. Heat is produced by mechanical action, as friction, percussion, and compression.
2. Heat may be produced by chemical action.
3. Heat is produced by electricity.
4. Our greatest source of heat is the sun.

Experiments:

Heat from friction: Many simple experiments to show this will suggest themselves to the teacher. Rub the hands together, rub a metallic button on the coat sleeve, saw a string across the edge of a board or pull it through the hand, bore with a small drill into the end grain of a piece of hard wood. In each case both articles which rubbed together become heated.

Applications: Sometimes we put to use heat produced in this way. We rub our hands together to warm them, we rub a match on some rough object, and the

heat produced raises the temperature of the head of the match sufficiently high to set it on fire. Most savages obtain fire by friction, rubbing two pieces of wood together till hot enough to set fire to some dry, light material.

The natives of Australia placed a flat piece of wood on the ground and pressed against this the end of a round piece, which they twirled rapidly with their hands till fire was produced. The North American Indians did the twirling with bow strings, and held the round piece in firm contact with the flat one by means of a stone. In Ernest Thompson-Seton's book, *The Two Little Savages*, there is a clear description of how it was done. The Eskimos' plan is somewhat similar.

Often we seek to prevent as far as possible the production of heat by friction, as when we grease the axle on which a wagon wheel rotates, or oil the bearings of a machine.

Heat from percussion: Let a pupil hammer a nail flat on a block of iron or a stone and immediately feel it. It may be too hot to hold in the hand. When a cannon ball is fired against an iron target, a sheet of flame is frequently seen at the moment of impact. Rifle and shotgun cartridges are fired by percussion caps, which explode when struck by the hammer of the lock. Sparks may often be seen when a horse's iron shoe strikes a stone.

Heat from pressure: This is especially noticeable if a gas is compressed. When a bicycle or automobile tire is being inflated, the heat produced by the compression of the air makes the pump hot.

When a compressed gas expands again it becomes cool. This can be shown by holding a thermometer in the stream of air issuing from an inflated tire or football.

Heat from chemical action: The most common examples of heat produced from chemical action are observed when fuels are burned, such as, wood, coal, oil, gasoline, alcohol, gas, peat, and others. These fuels, as they burn, unite with oxygen, forming new compounds.

Other interesting experiments can be made to show that heat is produced by chemical action. Place a lump of quick-lime in a can and pour water upon it. As it slakes, the can becomes hot. Or pour a little concentrated sulphuric acid into a test-tube half filled with water. The tube will probably become too hot to hold in the hand.

Our bodies are warm because food in the cells (first built up into living matter) unites with the oxygen which we breathe in.

Heat from electricity: When an electric current passes through a wire, heat is developed. The greater the resistance offered by the wire, the greater the amount of heat produced. A single dry cell in good condition is sufficient to show this effect. Join to one binding post of the cell a strand of fine iron wire drawn from a piece of window screening or from picture wire. Then, holding the wire taut, bring it in contact with the other pole of the cell. The wire will become red hot and probably melt in two. If the dry cell is not new, join several in parallel, or heat a very short piece of the iron wire. This can be done by attaching a piece of copper wire to one binding post and the iron wire to the copper.

Applications:

The applications of this heating effect of electricity are many and common. The filaments of electric lamps are heated until they glow, and so give off light. Electric stoves, toasters, flat-irons, curling tongs, soldering irons,

and other similar appliances all contain resistance wires which become heated as the electricity flows through them.

The sun as a source of heat: The most important of all our sources of heat is the sun. No experiment is necessary to show this; but if a convex lens is at hand and the rays of the sun are focused on a match head or a piece of paper or pine wood, its power is made very apparent.

Not only is the existence of all life, plant and animal, dependent upon the sun, but nearly all the energy employed by man in doing work comes from the same source. It is an interesting and profitable exercise to trace back to the sun the energy used, say, in lighting or heating our homes or in doing some piece of work. For example, the electricity used in lighting the home is produced by a generator driven by a water-wheel. This wheel is turned by water as it flows from a higher to a lower level. The water comes from a river, which is fed by tributaries having their sources in the hills. These streams receive the water from rainfall from the clouds, which have been formed from water vapour evaporated and lifted by the sun from the surface of the ocean.

TRANSMISSION OF HEAT

It is a matter of common observation that heat travels from one object to another. A basin of water standing on a hot stove soon becomes heated. A wind blowing from a warmer region raises the temperature of the one to which it is blowing. We hold our hands near a stove or radiator to warm them. There are only three methods by which heat may be added to or taken from a body. The experiments following illustrate these methods:

Transmission by Conduction:

Facts to be taught:

That metals are good conductors of heat; that gases, most non-metallic solids and liquids, are poor conductors; that some metals are better conductors than others.

Experiments:

1. Give to the pupils strips or rods of copper, iron, brass, or other metals, and of wood, glass, or other non-metals. The strips should be of the same lengths. Let the pupils hold one end in the hand and heat the other end. Those holding the metallic rods will soon find them hot throughout and may be obliged to drop them. The other rods may burn or melt, but do not become too hot to hold. This shows that metals are good conductors and non-metals are poor conductors.

If wires of copper, aluminum, brass, and iron are used, it will be found that this is the order in which they conduct.

2. Fill a test-tube with water and hold it in the hand obliquely, with the upper end in the flame of a spirit lamp. The water may be made to boil near its surface for several minutes, before any change of the temperature at the bottom will be perceived. Or, by means of a coil of wire inserted in the tube, hold a piece of ice at the bottom of the water, and the water at the top may be boiled without melting the ice.

These experiments show that water is a poor conductor of heat.

Regarding gases as conductors, we know that we can bring the hand very near a hot stove without burning it, which we could not do if air were a good conductor.

Applications: As the bottom of a flat-iron or the tip of a soldering-iron are cooled by use, heat is conducted

from their hotter portions to the cooled surfaces. Heat passes by conduction through the iron stove to the outside, and through the bottom of the kettle to the water contained in it. It may be noted that we use the conductivity of solids in most of our heating and cooking operations, though the distance through which the heat passes is always small.

There are many uses to which we put the non-conductors or insulators. We use a cloth or pad of paper to pick up warm metals. The wooden handles on flat-irons and kettles prevent us from burning our hands. We wear woollen or fur clothing in winter to prevent loss of heat from the body, since the air contained in the spaces between its fibres is an excellent non-conductor.

Pupils will think of many other examples, as feathers on birds, down quilts, asbestos or hair or felt coverings for steam pipes, sawdust for packing ice, double windows, hollow brick or tile for house walls. The so-called fireless cooker is an excellent example of the non-conducting power of felt or some other substance. Every farmer knows the efficacy of a layer of air-filled snow in preventing a deep freezing of the soil.

Transmission by Convection:

Fact to be taught:

That the unequal heating of a mass of fluid results in currents which tend to continue until the whole mass is of the same temperature:

Experiments:

1. **Convection currents in water:** Drop a few pieces of solid soluble colouring matter, sawdust or bits of the lead of an indelible copying pencil, into a beaker of cold water. Apply heat to the beaker just below the colouring matter and observe the resulting currents. A sealing

jar or a tin can will do instead of the beaker. If the former is used, stand it in a dish of hot water, if the latter, place it on the stove or heat with a candle flame.

Other forms of apparatus showing convection currents in water are described in the *High School Physics* and in *Science of Common Life*.

2. **Convection currents in air:** These are very easily shown. Take a pasteboard box such as a shoe box, and cut two holes an inch or more in diameter in its cover, one near each end. Light a candle and stand it in the box just below or projecting through one of the holes. Cover this hole, or if desired, both holes, with lamp glasses, or pasteboard, or paper tubes. The air currents can be made visible by holding a bit of smoking cotton cloth or touch paper above the tubes. The apparatus is improved by cutting away most of one side of the box and fitting in a piece of glass so that the current of smoke in the box may be seen. Strips of gummed paper will hold the glass in place, and may be used to close any unnecessary openings.

If one hole is made in the cover of the box and another in the end of the box near the bottom, the apparatus will closely resemble a stove in structure and action.

Applications:

Convection has been man's chief method of distribution of the heat produced by his fires for cooking and heating. Stove pipes and chimneys are simply convection pipes removing the smoke and furnishing a better supply of oxygen for combustion.

Diagrams of hot-air and hot-water systems of heating, of ventilating systems, and of equipment for maintaining a hot-water supply are given in the *High School Physics*.

Simple experiments to illustrate how these work are also described.

The water used to keep the engines of motor cars from overheating is kept in circulation in some cars by convection currents. The water surrounding the engine cylinders is being constantly heated, and that in the radiator constantly cooled. This causes a cooling current through them.

Winds are parts of huge convection currents in the atmosphere, one cause of which is the unequal heating of different parts of the earth's surface, and in consequence of this, the unequal heating of the air above it. In general, winds are set up toward heated areas, where the air is being forced upward by the pressure of the colder and heavier air of the surrounding regions.

Transmission by Radiation:

Facts to be taught:

That there is a third method of transmission of heat in which no material medium is necessary; that this transmission is in all directions from the hot object. That substances which radiate heat will also absorb heat well.

Experiments: Hold the hand an inch or two below or beside some hot object, such as the stove, a radiator, a heated metal ball, or the stove poker. The heat does not reach the hand by convection currents, as these always convey heat upward. Neither is it by conduction, as air is a very poor conductor. Moreover, the heat is felt instantly, but it takes an appreciable time for it to be conveyed by conduction or convection.

To show the effects of different surfaces on radiation and absorption of heat, take two similar tin cans and

make holes in the lids large enough to admit a thermometer. Blacken the outside of one box in the smoke of a candle or oil lamp. Put equal quantities of hot water at the same temperature in the cans, and place them in a cool place where there are no draughts. Test the temperature from time to time, noting which cools faster.

Similarly, fill equally the two cans with cold water, stand them at equal distances from a hot stove, and note which warms the faster.

Usually dark and rough surfaces radiate and absorb heat better than smooth bright ones. An excellent way of showing this is to lay a black cloth and a white one side by side on the snow where the sun is shining brightly. The snow will melt more rapidly under the black cloth. The day chosen for this experiment should not be extremely cold.

Applications: What colour is the most suitable for radiators, stoves, teapots; for summer clothing for people of our climate, and for winter fur of Arctic animals? Give your reasons.

Water vapour in the atmosphere checks the radiation of heat from the earth. Explain why clear nights in the winter are colder than cloudy nights. Why does dew form on a clear night and not on a cloudy one? Why is a mountain top or a desert so cold, especially at night?

ENGINES

To show the power of steam, partly fill a flask, test-tube, or bottle with water, cork it loosely, then boil the water until the cork is driven out; or let a stream of steam impinge on a toy paper-wheel so as to make it rotate.

In the steam engine a piston is driven alternately from one end of a cylinder to the other by steam pressure,

and this back-and-forth motion turns a crank which drives the machinery.

In the gasoline engine the piston is propelled by exploding a mixture of gasoline vapour and air in one end of the cylinder.

Good descriptions of the action of both the steam-engine and the gasoline engine are given in the *Ontario High School Physics*. Pupils will be able to state many examples of the use made of these engines.

ELECTRICITY

The Galvanoscope: Before experimenting in making an electric cell, prepare a galvanoscope for detecting a current. Wind about ten turns of insulated wire around a block of wood two inches wide and an inch and a half thick. Tie the turns of the coil together at the corners with thread, and then remove the block. Fasten the coil in a vertical position on a wooden base, by means of sealing wax or glue or brass pins or tacks. Suspend a magnetized sewing-needle in the centre of the coil, or place a compass in it. Stand the instrument so that the horizontal wires of the coil are parallel to the needle, and test it by touching the free ends of the wires to the binding posts of a dry cell. The movement of the needle will be taken as the indication of a current of electricity.

A Cell: Plates for constructing a cell can be obtained conveniently from an old dry cell. Use the carbon rod and a strip of zinc an inch or two wide cut from the side of the cell which has the binding post. Stand these plates in a large tumbler, or earthenware or enamelled cup, but do not let them touch each other, and attach to them the wires of the galvanoscope. Now pour into the tumbler in succession solutions of any acids or bases or salts that are available, and note whether the needle

turns, and if so, how much. Common materials that may be used are table salt, vinegar, Gillett's Lye, household ammonia, washing-soda, baking-soda, and the contents of an old dry cell. If sulphuric acid is available, use a weak solution of it also. Rinse the plates and cup thoroughly before putting in a new liquid. See which material gives the strongest current by noting how far the needle turns. Try also a solution of sugar or some coal-oil.

Use the best solution with various pairs of plates, as copper, iron, lead, silver (a coin), glass, wood.

From the results of these experiments the pupils can decide what are the essential parts of a cell; namely, two different conducting plates in a conducting liquid that acts chemically upon at least one of them.

A storage battery has the same essential parts. When it is being used, its plates tend to become alike in composition until it will give out no more electricity. By charging they are made different again, and so the strength of the battery is renewed.

In this connection a very interesting lesson or two can be taught on the topic "The Hydro-Electric System of of Ontario." Excellent maps of the system are available in the reports issued by the Hydro-Electric Power Commission of Ontario.

Two or three dry cells will furnish sufficient current for the following experiments. Often the cells discarded from rural telephones have still enough energy for conderable use if several are connected in series or in multiple-series. See *High School Physics.*

Experiments:

Make a horseshoe magnet, by bending a nail and winding several layers of insulated wire about each end

in opposite directions. Test this magnet and compare its strength with the straight one.

If possible let pupils examine instruments containing electro-magnets, such as an electric bell, a telegraph sounder, or telephone receiver.

An experiment to illustrate the use of electricity in producing light and heat is given under "Sources of Heat." Let the pupils examine electric lamps, and explain to them that a carbon or tungsten filament is used, because these do not melt at nearly white heat. To prevent them from burning up they are inclosed in glass bulbs from which the oxygen has been exhausted. (The iron wire used in the experiment probably both melted and burned.)

Applications:

Recall the many common uses of electric lights: For lighting buildings and streets, in flashlights, automobiles, motion-picture machines, and radio sets.

Have the pupils examine, also, some electric heating device in which the heating element is visible; for example, a toaster. They will tell of the many other examples of electricity used for heating, as in flat-irons, warming pads, stoves, and curling-tongs.

The production of power by electricity can be shown by means of a cell or two and a boy's toy motor. In places where electric power is available, the pupils will know about motors being used for driving fans, vacuum cleaners, sewing-machines, and washing-machines in homes, and for running street-cars and the machinery of factories. The electric starter on an automobile is a motor driven by electricity from the battery.

CHAPTER XVI

THE TECHNIC OF NATURE STUDY

Collections

School collections of such objects as noxious weeds, weed seeds, wild flowers, noxious insects, woods, leaves of forest trees, minerals, rocks or stones of the locality, etc., should be undertaken.

All the pupils should contribute as many specimens as possible to each collection and should assist in the work of preparing them.

In addition to assisting in the making of the general school collections, those pupils who show special interest in this phase of Nature Study should be encouraged to make individual collections.

Collections, when properly prepared, have a value within themselves, because of the beauty and the variety of the forms that they contain, and also because of their usefulness as aids in illustrating nature lessons and in identifying insects, weeds, etc. Nevertheless, the chief value of the collection lies in the making of it, because this gives the collector a training in carefulness and thoroughness, and also leads him to study natural objects in their natural surroundings.

INSECT COLLECTIONS

A school collection made from the insects studied, is useful for future reference in the identification of insects. Do not allow any insect to be killed unless it is a good specimen intended to fill a place in the collection, or unless it is known to be an injurious insect. The teacher, by

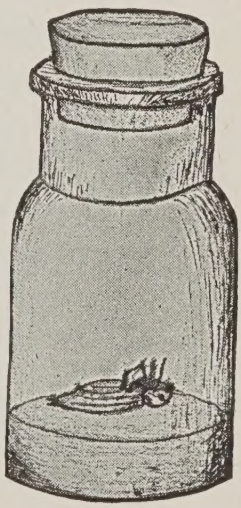
exercising proper control of the collecting, has an effective means of teaching the sacredness of life. The fact should be emphasized that killing even an insect, is cruel, when there is no good reason for so doing.

In addition to a collection of insects, including larval and pupal forms, collections of insect nests, of plant galls, of markings of engraver beetles, of burrows of tree borers, and of the destructive workings of insect pests should be made.

While nothing is more beautiful than a carefully prepared collection of moths, butterflies, and beetles, with their infinite variety of form and colour, nothing is more disgusting than a badly preserved collection of distorted, shrivelled, vermin-infested specimens. The teacher should avail himself of the collecting instinct which is prominent in boys of nine to fourteen years of age, to develop in them habits of carefulness, neatness, and thoroughness, and a desire to have things done well.

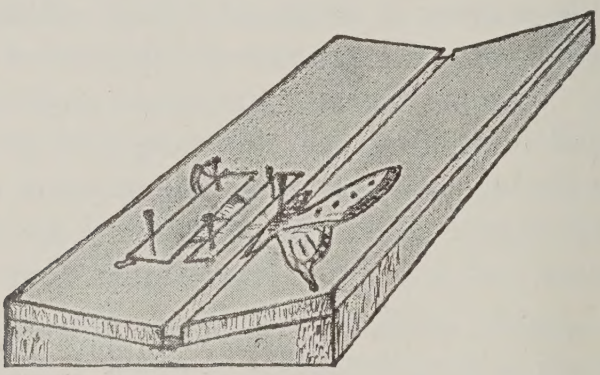
HOW TO MAKE AN INSECT COLLECTION

See Manual on *Manual Training*, for details for making collecting appliances. Agricultural Bulletin No. 8, *Nature Collections for Schools*, Department of Education, Toronto, for detailed instructions on making insect collections.



The outfit for collecting is neither expensive nor hard to prepare. It consists of: (1) An insect net for catching the insects, made by sewing a bag of cheesecloth to a stout ring one foot in diameter, which is fastened to a broom handle; (2) a cyanide bottle for killing the insects, prepared by pouring some soft plaster of paris over a few lumps of potassium cyanide (three pieces, each of a size of a pea) in a wide-mouthed

bottle. When the plaster has set, keep the bottle tightly corked to retain the poisonous gases. (3) Pins to mount the specimens, entomological pins, Nos. 2, 3, and 4 are the best for general use. Beetles are usually pinned through the right wing cover at about one-fourth of the length of the cover from the front end of it. Moths and butterflies are pinned through the thorax. Small insects may be fastened to a very small pin, which in turn is set into a bit of cork, supported by a pin of ordinary size. (4) Spreading board for moths and butterflies, and (5) insect boxes to hold the speci-



mens should be secured before the collection is begun. It is a common mistake to believe that any box whatever will do for storing insects. By providing an effective means of permanently preserving the specimens, encouragement is given to the efforts of drying, spreading, pinning, and labelling. If stored in cigar-boxes, pasteboard boxes, and other such makeshifts, the specimens soon become broken and covered with dust, thus causing the collectors to become discouraged; hence it is advisable to secure good boxes from dealers in entomological supplies.

A sponge saturated with carbon bisulphide should be placed in the box at intervals of not more than three

months, in order to kill the parasites that destroy the specimens.

Entomological supplies can be obtained from Chapman & Co., London, Ont., or from G. M. Hendry Co., Victoria Street, Toronto, or from Watters Bros., Guelph, Ontario.

PLANT COLLECTIONS

The instructions given below for collecting, pressing, and mounting plants are applicable to wild flowers, grains, grasses, and weeds.

The Specimen.—Select a plant which in form and size is typical of its species and which is in full flower. Care must be taken to dig down and secure the root.

If the plant is too large for the mounting sheet, cut out the central part, and use the root, lower leaves, upper leaves, and flower. If the root is very thick, cut slices lengthwise off the sides, so as to reduce it to a flat form that is not bulky.

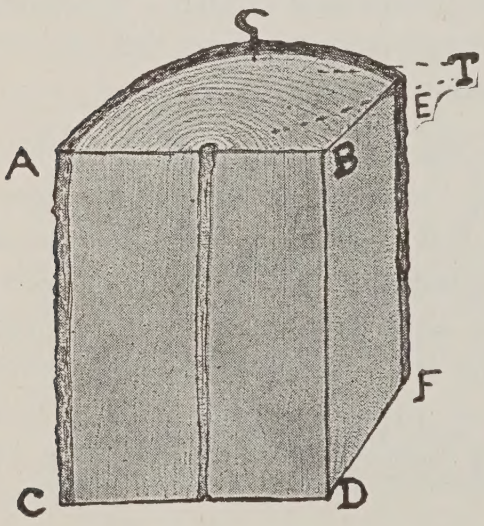
Before the plant has had time to wither, spread it out flat on a sheet of paper and spread another sheet over it, taking care to lay flat the leaves and flower. Blotting-paper is preferable, but any soft paper that will absorb moisture makes a very good substitute.

Pressing and Drying.—Place several sheets above and below the specimen. Any number of specimens, prepared as described in the last paragraph may be placed in a pile, one over the other, on the floor or a table. Place on top of the pile a board which is large enough to cover the surface and on the board a weight of about fifteen pounds of bricks or other convenient material. (The weight prevents the shrivelling and distortion of the plants.)

To prevent discoloration and mildewing of the plants, the papers around them must be changed at the following successive intervals: Two days, three days, five days, one week, etc., until the plants are quite dry. The length of time required for pressing and drying depends upon the quantity of sap in the plants and also upon the dryness or humidity of the atmosphere.

Mounting.—When dry, the specimens are mounted on sheets of heavy, white paper. These sheets are cut to a standard size, eleven inches by fourteen inches, but sheets seven inches by eleven inches are often used. The best method of attaching the plant to the sheet is by pasting narrow strips of gummed paper across the plant in such places as will serve to hold all parts of it in position.

Labelling.—The name of the specimen, the date of the collection, the place from which collected, and the name of the collector are to be neatly written in a column in the lower right-hand corner of the sheet, or on a printed label pasted on this corner of the sheet.



Collections of leaves may be prepared by the same process. Leaves will retain their autumn tints if their surface is covered with varnish or paraffin, which will prevent the admission of air.

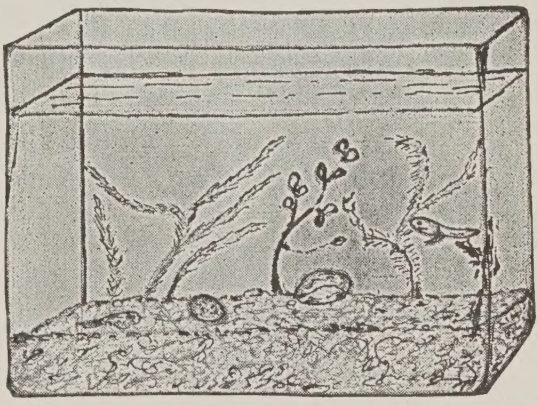
To cover with paraffin dip the leaf for a moment into melted paraffin.

WOOD COLLECTIONS

A good form of wood specimen is illustrated. This is prepared by cutting a cylinder from the trunk or limb of a tree, the diameter of the cylinder being from 1″ to 2″ and the length 2″ to 3″.

THE AQUARIUM

A large, glass aquarium may be purchased from any School Supply Co. at a cost of a few dollars, but a small globe-shaped aquarium such as is used for gold fishes will be found suitable for school purposes. If it is not possible to secure either of these, a large glass jar, such as a battery jar or large fruit jar, will answer quite well.



To set up the aquarium, put into the jar about two inches of clean shore sand (sand from a sand pit, washed until the water comes away clear, will do). Secure from a pond some water plants, and place them in the jar with roots covered with sand and secured in position by means of small stones. Pour in water until the jar is nearly full, taking care not to wash the roots out of place. Then put in a freshwater clam and a few water snails. These act as scavengers, for the clam feeds upon organisms that float in the water, while the snails eat the green scum that grows on the grass. The other aquarium specimens may then be put in. One fish about three inches long to a gallon of water is about the right proportion.

When there is a sufficient quantity of plant life to keep the water properly oxygenated and enough life to supply the carbon dioxide necessary to keep the plants growing well, the aquarium is said to be *balanced.* (The balanced aquarium does not require that the water be changed more often than once in two months.)

Too much direct sunlight causes too rapid growth of green slime, hence the aquarium should not be set in a window. The best position is close to a window through which the sun will shine upon it for an hour or a little longer each day.

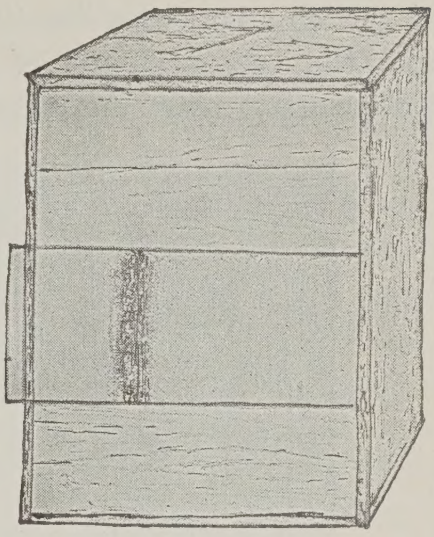
Do not supply more food to the animals in the aquarium than they can eat.

Crayfish, perch, trout, and other fishes are destructive of insect life in the aquarium, hence they must be kept in separate aquaria.

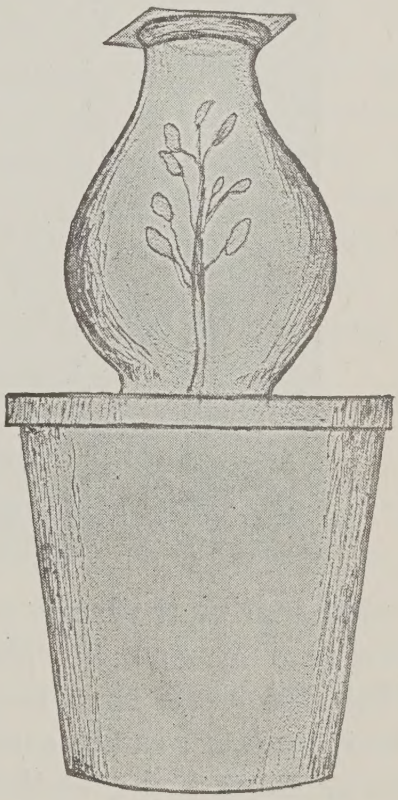
Suitable animal life for aquaria: Mosquito larvæ, dragon-fly larvæ, caddice-fly larvæ, crayfish, clam, water snails, tadpoles, fish of several kinds, frog and turtle. The caddice-fly is an especially interesting creature to study by the use of an aquarium.

INSECT CAGES AND INSECT LARVÆ

To study the metamorphosis of butterflies and moths, it is necessary to have an insect cage. This can be purchased from any dealer in entomological supplies, or it can be made by the pupils in the Manual Training class.



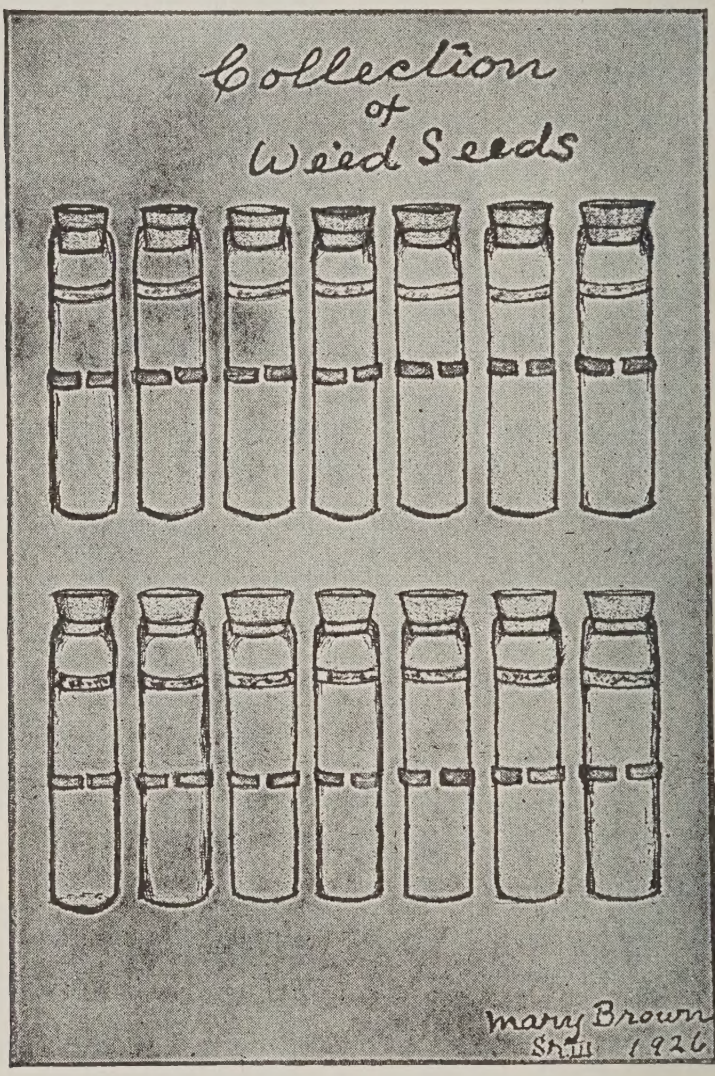
(See Manual on *Manual Training.*) A very satisfactory cage may be made from a soap box, by the teacher or pupils, by tacking wire gauze over the open surface of the box, removing the nails from one of the boards of the bottom, and converting this board into a door by attaching it in its former place by light hinges and a hook and staple. The box, if now placed on end with two inches of loose soil in the bottom, will constitute a satisfactory insect cage or vivarium.



A modified form of the vivarium just described is illustrated. In this form, a sliding pane of glass, "G," takes the place of a hinged door.

A large lamp chimney with gauze tied over the upper end is useful for inclosing a small plant upon which eggs or insect larvæ are developing. The base

of the chimney may be thrust an inch into the soil, and the development of the larva as it feeds upon the growing plant may be studied.



For rearing the larvæ of an insect, a good device is to grow in a flower-pot a plant on which the larvæ feed. When the larvæ have been secured and placed on this plant, the latter can be covered with a large lamp chimney having gauze tied over the opening in the top.

SEED COLLECTIONS

During the latter part of the summer and in the late autumn the seeds of the weeds that the pupils have identified should be collected.

Instruct the pupils to rub the ripened seed pods between the hands until the seeds are threshed out, at the same time blowing away the chaff. Place the seeds in small phials, or in small envelopes, and label them carefully. If possible, fill each phial so that there may be sufficient seed for use by all the members of the class in the lessons on seed description and identification which are to be taken during the winter months, when nature study material is less plentiful than it is in the summer and autumn. The phials or envelopes may be stored in a shallow box, or the phials may be mounted on a stout card, being attached to this card either by a strong thread sewed through the card and passing around the phial, or by brass cleats, which may be obtained with the phials from dealers in nature study supplies.

BIRD HOUSES

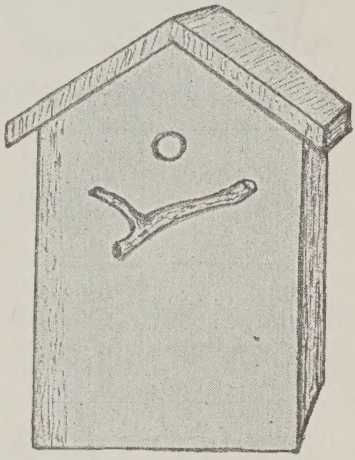
For a boy to have a bird of his own, one that has accepted his hospitality by making its home in a house he has offered it, and thereby becoming part of himself, will do more to develop in him a sympathetic and protective interest in bird life than countless numbers of class room lessons upon birds. Moreover, the provision of suitable homes for birds and the protection that neces-

sarily becomes part of this provision are among the best means of fostering bird life. The resulting increase in the number of birds ensures for their benefactor a protection of his forests, fields, and gardens against the ravages of insects. Neil M. Ladd, of Greenwich, Connecticut, found, by a careful survey of his estate of ten acres, that there were on it only twelve birds' nests, representing four species. After four years' effort in providing suitable bird houses and watchful protection, the number of nests had increased to seventy-five, representing twenty species. Every school pupil of Ontario has heard of Jack Miner's bird sanctuary at Kingsville, and of the remarkable increase in the number of birds of many species that it contains; this increase being the result of making adequate provision for the needs and for the protection of bird life within its boundaries.

In the small space that can be given to the subject of bird houses, only the mere outline of the general principles underlying their construction can be outlined, together with limited tables of details for houses suitable for a few of the commonest birds.

It is generally agreed that a house, in order that it may be acceptable to a bird, must have an exterior resembling the natural nesting-place of the bird. But even this principle is not accepted by such birds as the house-wren, blue-bird, tree swallow, and the chickadee. These prefer a house of the plain box type to the more natural looking type made from the section of the trunk or branch of a tree. Other birds, however, such as the downy woodpecker and hairy woodpecker, prefer the tree-trunk type.

Baron Von Berlepsch, the befriender of birds in Germany, claimed that not only should the exterior of the house imitate the natural nesting-place of the bird, but the interior should also be so designed as to reproduce the features common to the interior of the natural nest of the birds. From the fact that, of the fifteen thousand bird boxes made after his designs and set out on his estate and in other parts of Germany, fully ninety per cent were accepted by the birds, there can be little doubt that there is much truth to his claim.



There is plenty of evidence gathered from many observations made both on this continent and in Europe that birds of different species have very definite tastes in the matter of home-making. To these tastes the builder of bird houses must conform if he wishes to secure a satisfactory number of tenants.

The following table contains the details for houses that are acceptable to birds whose natural nesting-place is a hollow in a tree.

Bird	Size of floor of house	Size of hole	Depth of bottom below the hole	Height of house above the ground
Wren	4″ x 4″	1″	6″ to 8″	6′ to 10′
Chickadee	4″ x 4″	1⅛″	6″ to 8″	6′ to 8′
Downy woodpecker	4″ x 4″	1¼″	8″ to 10″	8′ to 10′
Blue-bird	4″ x 4″	1¼″	8″ to 10″	10′ to 15′
Flicker	7″ x 7″	2½″	16″ to 18″	6′ to 20′
Martin	6″ x 6″	2½″	1″	15′ to 20′

Birds prefer houses that are set on posts to those that are on trees. If set on a tree that stands by itself, the

house is more readily accepted than if set on a tree in a grove or thicket. Martins prefer colony houses.

Birds that build in open houses also show differences in their choice of homes. The catbird, song sparrow, and brown thrasher prefer houses with four open sides and placed in shrubbery, while the robin and phoebe prefer a house that is open on one side only.

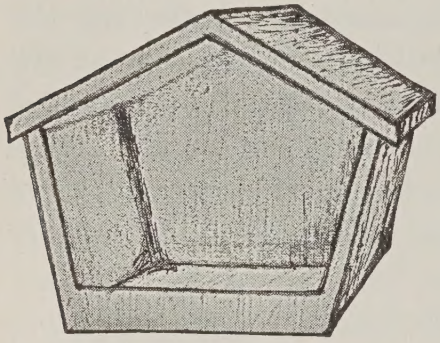


Table showing details for open house types:

Bird	Size of floor	Sides open	Height from floor to roof	Height of house above the round
Robin.....	6″ x 6″	one	6″	6′ to 15′
Phoebe.....	6″ x 6″	one	6″	8′ to 12′
Song sparrow..	6″ x 6″	four	6″	1′ to 3′
Catbird.....	6″ x 8″	four	8″	3′ to 10′

For further details on the subject of bird houses and bird protection apply to the Department of the Interior, Parliament Buildings, Ottawa, for *Bird Houses and Their Occupants*, by P. A. Travener, which gives plans and specifications for building bird houses.

ELEMENTARY SCIENCE

Apparatus and Materials

It is a mistake to suppose that expensive apparatus and materials are necessary for teaching this course. Useful experiments in every topic assigned for Third and for Fourth Forms can be performed by using materials that are obtainable from the homes of the

pupils or from general stores. The following materials mentioned in the descriptions of the experiments can be obtained at little or no cost from household stores or other sources, and with these most of the experiments can be performed: Tumblers, bottles of various shapes and sizes, fruit jars, corks, tin cans, lamp chimneys, sheets of glass, wire screening, wire of various kinds, sealing wax, rubber bands, sheet rubber, bolt and nut, needles, nails, candles, boxes of various sizes, copper and zinc sheets, horseshoe magnet, pocket compass, toy electric motor, magnifying glass, bicycle pump, bicycle tire, thermometer, dry cells used and new, spring balance, pulleys, animal membrane, tools as needed, salt, lime, sugar, vinegar, Gillett's Lye, household ammonia, washing-soda, baking-soda, baking-powder, yeast, flour, indelible or copying pencil.

For many of the experiments some source of heat is necessary. Often the stove is all that is needed; sometimes a candle or two will serve; an alcohol lamp can easily be made from an empty ink bottle by covering it with a piece of tin through a hole in which several strands of string are drawn for a wick. An empty paste bottle with its perforated cap lacks only the wick. Such a lamp must be kept corked when not in use, to prevent evaporation of the alcohol. Always keep an alcohol lamp well filled to prevent explosions. One of the various forms of "solid alcohol" or "canned heat" outfits is especially useful if a large flame is desired for rapid heating. Directions are given in connection with the topics to which they relate, for making the following pieces of apparatus that may be kept for repeated use: Thermometer shelter, wind vane, rain gauge, substitute for ball and ring, pyrometer for showing linear expansion

of solids, rod and gauge for the same purpose, lift pump model, convection currents apparatus, galvanoscope, electric battery, electro-magnet.

The following materials and chemicals are desirable, and can be obtained from a dealer in scientific apparatus. The chemicals can usually be supplied, in the small quantities required, by the local druggist. The prices are approximate.

Alcohol lamps	$ .35
Thistle tube	.10
Barometer tube	.50
Glass tubing at 60c. per lb	.15
Rubber tubing at 5c. per foot	.10
Ball and ring	1.20
Compound bar	.85
Florence flask, from 10c. up	.30
Test-tubes, 5 inch, per dozen	.20
Rubber stoppers, 6c. each, up	.25
Test-tube holder, wire	.10
Capillary tubes	.35
Pump model	1.20
Bar magnet	.35
Glass funnel, 3 inch	.20
Beakers from 12c. up	.25
Evaporating dish—3 inch	.25
Chemical thermometer from 35c. up, say	.60
Retort stand with two rings and clamp	1.80
Filter paper, 1 package of 6 inch	.25
Test-tube brush	.08
Clamp for closing rubber tube	.15
Electric bell	1.00
Electric motor	2.00
Balance	9.00
Set of weights	4.00
Alcohol for burning—pint	.40
Sulphuric acid—8 ounces	.20
Nitric acid—4 ounces	.10
Hydrochloric acid—8 ounces	.20
Potassium bichromate—1 ounce	.15
Potassium permanganate—1 ounce	.10
Potassium chlorate—1 ounce	.10
Manganese dioxide	.20
Copper sulphate—1 lb	.30
Sulphur—½ lb	.10
Iodine crystals—¼ oz	.25
Mercury—1 lb	2.00

REFERENCE BOOKS

High School text-books in Science

Millikan & Gale, *Practical Physics*, Ginn & Co., Boston

Simmons & Stenhouse, *Science of Common Life*, The Macmillan Co., Toronto

Gregory & Hadley, *A Class Book of Physics*, The Macmillan Co., Toronto

Fuller, Brownlee & Baker, *Elementary Principles of Physics*, Allyn & Bacon, Boston

Brownlee, Fuller & Others, *Elementary Principles of Chemistry*, Allyn & Bacon, Boston

Horner, *Weather Instruments and How to Use Them*, Witherby & Co., High Holborn, London, England

PICTURES, REFERENCE BOOKS

Bird Guide, Parts I and II. Reed. Musson Book Co., Toronto. Each, in paper $1.25
Each, in cloth 1.50
Manual of Nature Study. Comstock. McClelland & Stewart, Toronto 5.00
The Forest Trees of Ontario. J. H. White. King's Printer, Parliament Buildings, Toronto ..... .25
At the Farm. Evelyn Hardy. Thos. Nelson & Sons, Toronto 1.75
Domesticated Animals. Shaler. Scribners' Sons, New York 2.50
Birds of Ontario in Relation to Agriculture. Nash. Department of Agriculture, Parliament Buildings, Toronto .... .25
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